**Principles of Engineering System Design**

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**Lecture - 22**
**System Design Examples: (Continued) InSeKTs**

Dear friends, welcome back. In the last few lectures we have been discussing about some of the examples of system design. We discussed how the system design principles can be applied to some practical examples. So, one example on the vehicle navigation system design basically for helping the drivers as well as passengers to find out the location and navigation supports. That was one example which is auto link system.

And then we have been discussing about another example on another system design basically a known as InSeKTs. Basically, it is a Institute Service Key of Terminals. So, we discussed about the objective of these particular system, and what are the basic requirements, and how do we identify the requirements through scenario analysis, and input output trace and then we discussed about the requirement identification and how do we develop the originating requirements document or ORD.

So once we have this, we discussed about the context diagram and then what are the external systems associated with remain system. In the next task is, basically to go and analyze the functions of the system or we go for a functional decomposition.

So, as we explained in the previous lecture.

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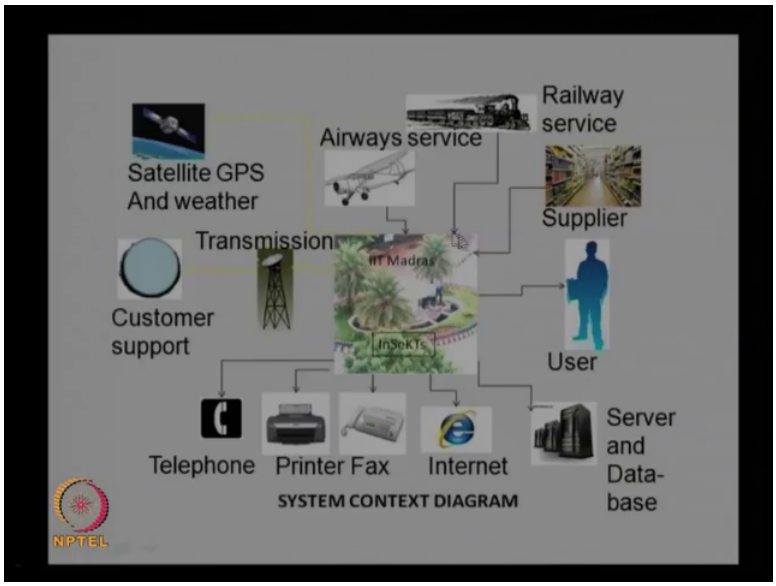


The system context diagram is shown here. So, this is the system or we have many subsystems and external systems acting or used in the main system through the context diagram shows the GPS system as an external system then other service providers is external system user as an external system. And then the server and database as external systems and of course, all other peripheral devices also.

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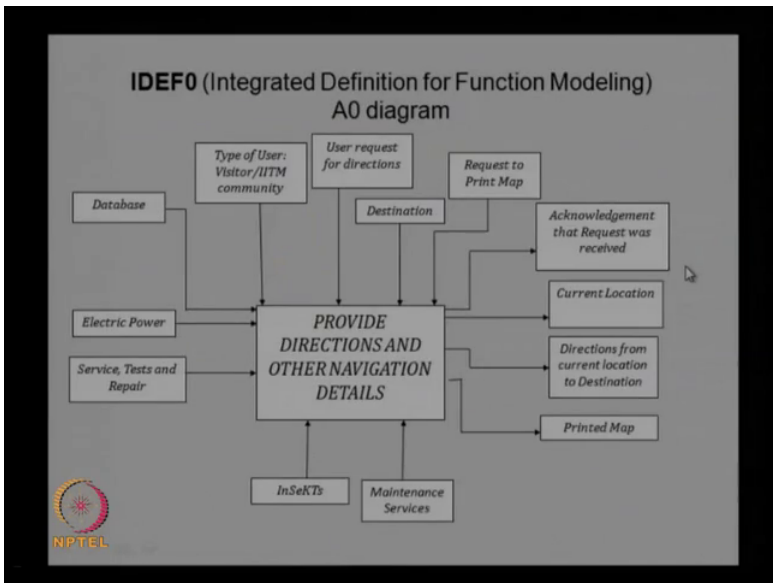


The main objective; we already explain that it is basically to provide the services for the visitors as well as to the students. So, in order to do the functional decomposition we use

the method IDEF0 when we discussed about functional decomposition. So, IDEF0 is a diagrammatic method of decomposing the functions in to sub functions. So, here we have different diagrams like A 0; A hyphen 0, A 1, A 2, A 3 like that. So, A 0 is the context diagram.

So, here in this diagram we will show the system as well as it is external systems and the context in which the system is being used. So, the main function we can say provide directions and other navigation details to the visitors of course, you can have additional functions also, but here we show this as the one of the main functions and then what are the external systems and interactions needed for the system are shown here in the context diagram and then InSeKTs the main hardware which actually provides you this function.

So, this is the context diagram or A 0 diagram and then we try to decompose this function or this diagram into sub functions. So, we start with this main function provide directions in other navigation details as a main function and then decompose this into sub functions. So, when we decomposed we will be getting the A 1 diagram this is the review of the previous diagram; so for better clarity shown it as a separate diagram. So, here you can see this is the main function provide directions and other navigation details and then you have the hardware which actually provides this meant for service and then you have the maintenance services and maintenance system as an external system and you have all other external interactions and eternal users the different types of users then the user request different kinds of request and then there are destination information and then request from customers.

Similarly, the output from the system as acknowledgement and then location details navigation details and then print out. So, these are the outputs these are the main inputs to the system now we will try to develop it further or we will decompose this function further using IDEF0 methods.

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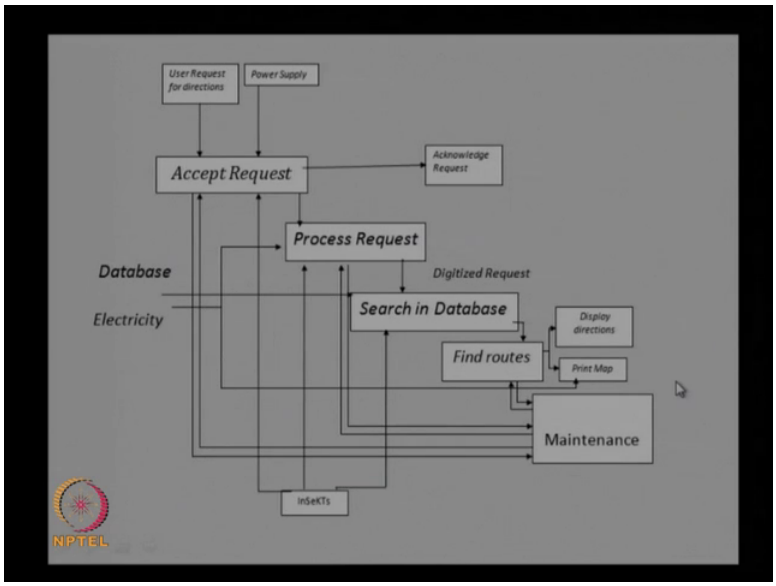


So, we will go for the A 1 diagram which actually shows the sub functions which can be identified from the A 0 function. So, the A 0 function is decomposed into 4 main functions here as you can see accept request process request search database find routes. So, these are the main 4 functions which can be identified from the A 0 function. So, the A 0 function is decomposed into 4 functions here and then you can see the type of interactions taking place between these functions and the inputs coming to these functions as well as the output from this function.

As you can see, the inputs are basically the user request then the power supply in the database and other infrastructural supports and then you have the output as acknowledge request then the display directions and the print map depending on the request from the customer we can actually provide a printed map or other kind of output. So, these are the interactions taking place. So, it is not only the interaction with outside systems basically we will be having lot of interaction within the systems also within the sub functions also there will be many interaction. So, the output from this will be going to the process request that the request will be processed here and the process request should be sending the data to the searching database function.

So, here the digitized request will be passed to this function and then the output will be passed to the find route function. And then finally, the output will be given from here. So, these are the 4 functions which can be identified from the A 0 function this is shown

with more clarity here in this diagram it is the same diagram which I explained earlier, you can see here this is the accept request function with the user request for directions and the input power supply as the inputs. And then you have this output coming from here to the process request function where the digitized request will be going to the search database. So, here the output will be acknowledgement of the request then the search in database then find possible routes and that route will be displayed as a output to the customer.

So, these are the 4 main functions we can identify from the first function. So, this diagram is known as A 1 one diagram. So, here actually we are decomposing the A 1 function into 4 functions now all these functions can be decomposed further into small functions. So, we take one function here and then try to decompose that into small functions. So, we can take accept request as one function A 1 one function and then we will decompose this A 1 function, then we will decompose this into sub functions. So, that is shown here the accept request function is decomposed into small functions here. So, these the accept request the first function then digitize request is the next function in that one and then once you have the digitization of the request, it will be passed to the next function this is basically acknowledge request.

So, there is another function to provide an acknowledgement or the output to show that the request has been accepted and that will be giving the output to the main to the next function with or actually the output will be shown as a display or as some kind of a feedback to the customer. So, these are the sub function which you can identify from the A 1 function. So, this is A 1 one diagram. So, it will be having 3 sub functions here accept request digitize request and acknowledge request same way we can actually further decompose this into small functions like this we can actually decompose all these functions into small functions and then we can get complete functional decomposition of the system.

So, once we have the complete decomposition of the system we can actually develop a functional decomposition at chart. So, functional decomposed in chart is an output of the IDEF0 a diagrams. So, we will take at the functions identified in the IDEF0 diagram and then represent them as a chart as a hierarchical chart that will give you the functional decomposition. So, once we have the functional decomposition it actually tells us that what are the functions to be provided in the system as we show in some of the previous

examples, we can actually write down all the functions like accept request digitize request acknowledge request like that and that will provide you an hierarchy of functions and based on this functional hierarchy we can actually develop a physical architecture.

As I mentioned earlier there are 2 types of physical architecture we developed one is the generic physical architecture the other one is the instantiated physical architecture in the generic architecture, we will identify the generic components to provide the functions and in the instantiated one; we will try to give the details of these components which actually can be used for that particular function.

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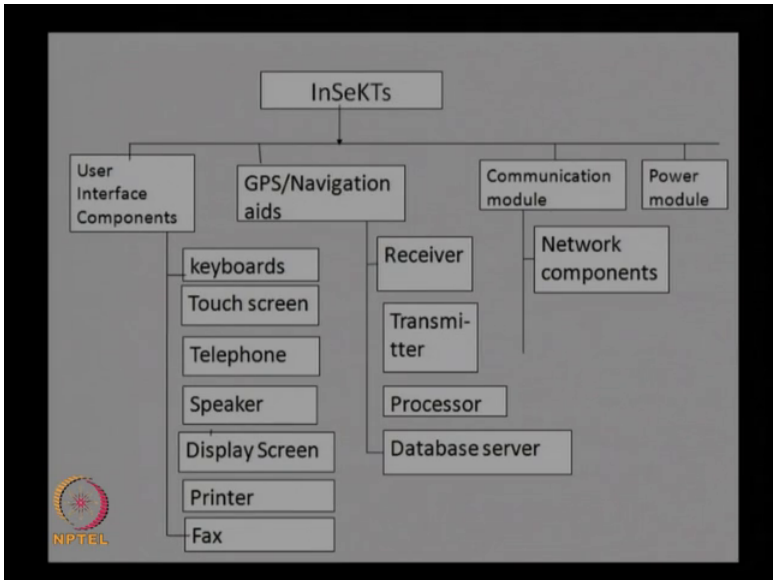


So, what we are shown here is a generic physical architecture for the InSeKTs system as we can see there are multiple sub functions we need to provide in the system and not shown the complete diagram here because of the lack of space in to show the hold structure here. So, we can see the user interface is one important sub function which actually provide you input and output from the system.

So, that is one sub functions of for that we need to have a user interface. So, user interface components is one then the GPS and navigation aids and communication module then power module than other input output modules also will be there. So, here again for the user interface we can see that there are different kinds of inputs and output requirements. So, we can use keyboards or touch screen telephone speaker display screen printer fax. So, these are the component which can be used for the user interface

similarly for GPS and navigation aids we can see there are receiver transmitters processors and database server as the components for providing this particular function for communication module again we can have a network components and other hardware and then of course, you can include the software also for communication.

Then power module also we can have the normal power supply or the battery power supply as the additional components over here. So, like this we can develop the generic physical architecture. And I, now to get the instantiated physical architecture we can go for the morphological box and identify the components which can be used for these purposes and we can see what kind of actual component or what device need to be used for these purposes. So, that is the next task. So, we can go for morphological box and then get the details.

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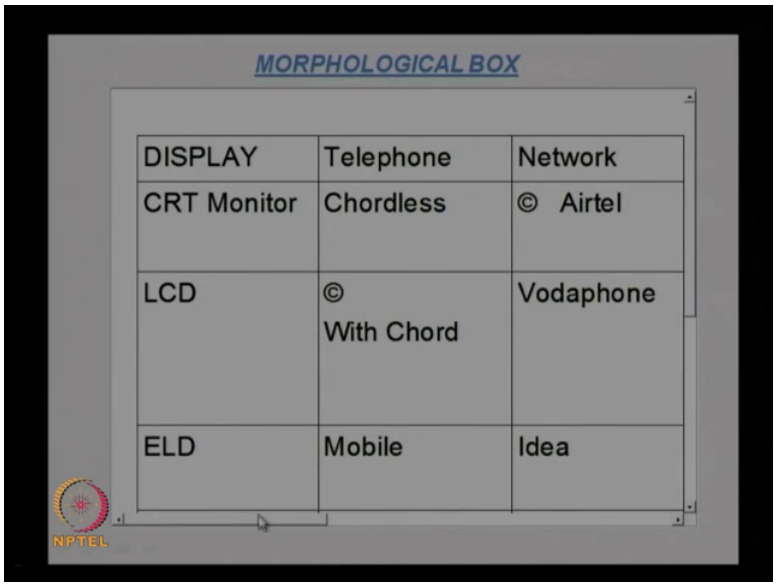


So, here again we have different options I am just showing a very simple example here you can actually go for all components you can have actually developed the morphological box.

So, here I have shown the display the telephone and the network options as well as the printers and the direction are showing options and the database options the network options.

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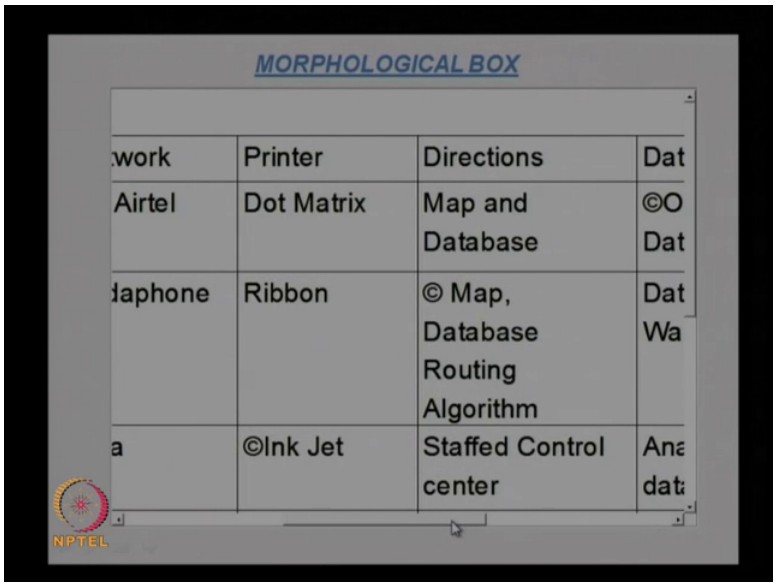


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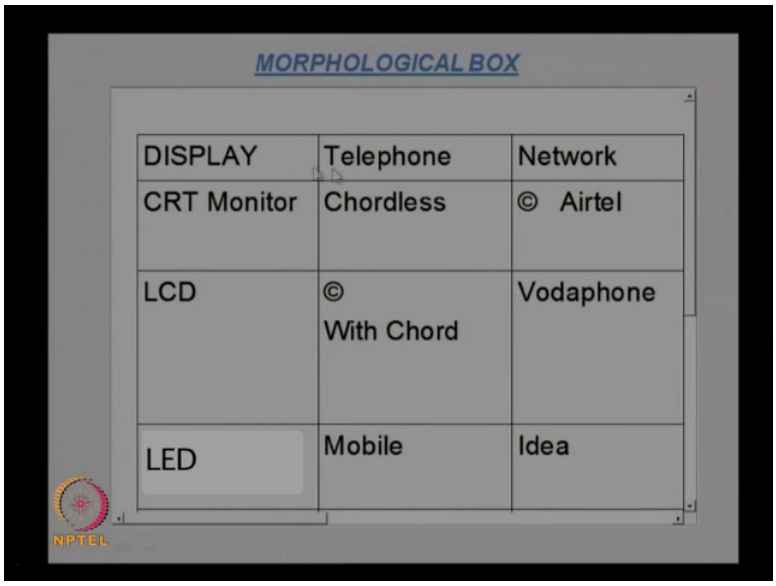


So, here there are taken few components and then developed the morphological box as you can see for the display you can have a different kinds of monitor CRT, LCD electronics or plasma display or touch screen display and for the telephone you can have a cordless phone or with the code or with the our mobile phones you can have a network various existing network and we have chosen or you can have a dedicated network for the system can have different kinds of printers ink jet or dot matrix for the directions you can have different databases or we can have the already existing softwares or algorithm can be used for this purpose.

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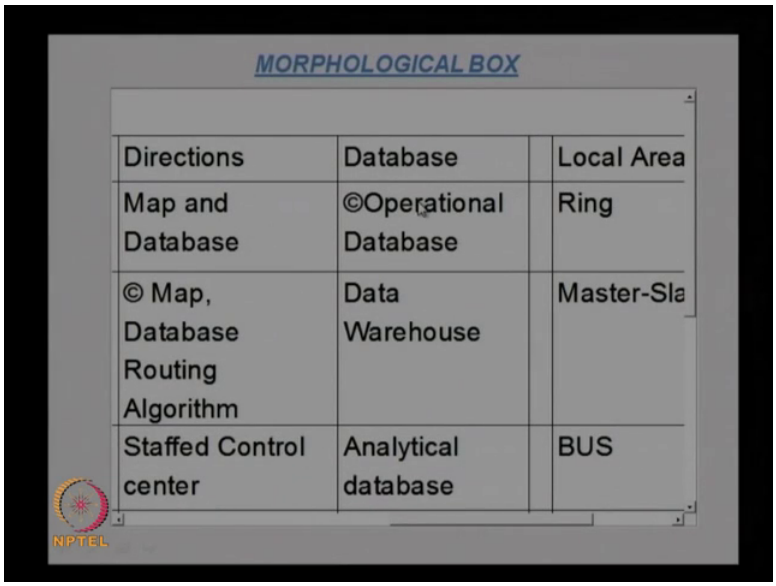


And the database can actually be again chosen from the existing database or we can develop our own database and then local area network can be opted based on different options available.

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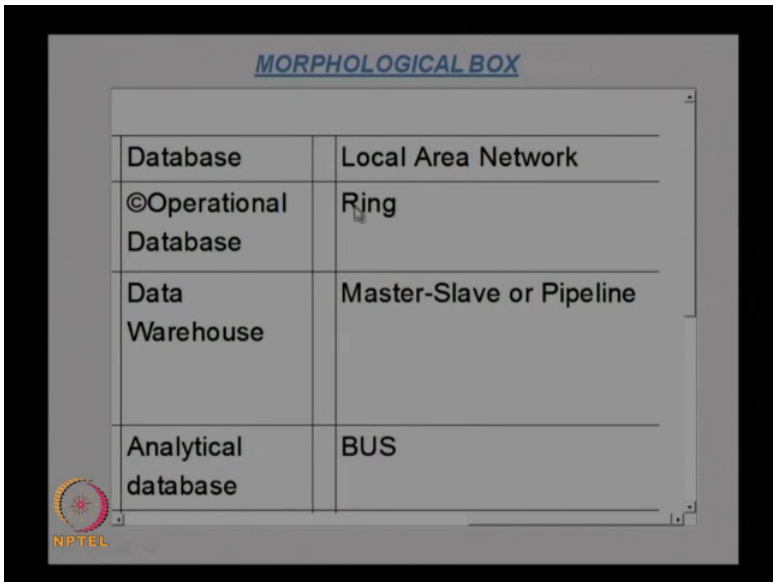


Please discuss about the ring our master slave or architecture. So, we can actually choose any one of this architecture for the network. So, like this we have different options and based on this morphological box you can choose component for input output as well as

the directions and navigation and that can actually be shown in the architecture, then it becomes a instantiated physical architecture.

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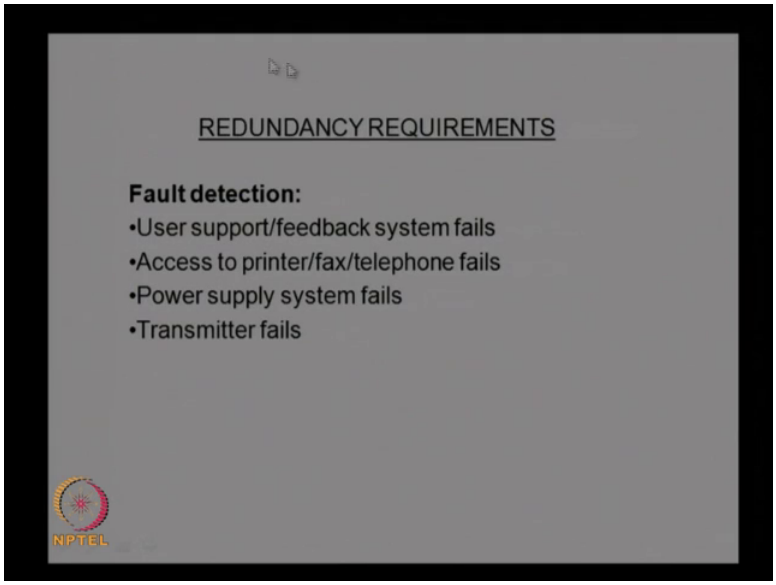


And apart from this requirements identified will be having redundancy requirements because of the fault tolerance. So, we need to have methods to prevent the fault spreading to other parts. So, we can have the various kinds of fault detection method. So, we can actually have fault detection for the following cases were the user or support feedback system fails or the access to printer or fax telephone fails power supply system fails or transmitter fails. Of course, you can identify many other scenarios also and try to provide the redundancy requirement for these cases.

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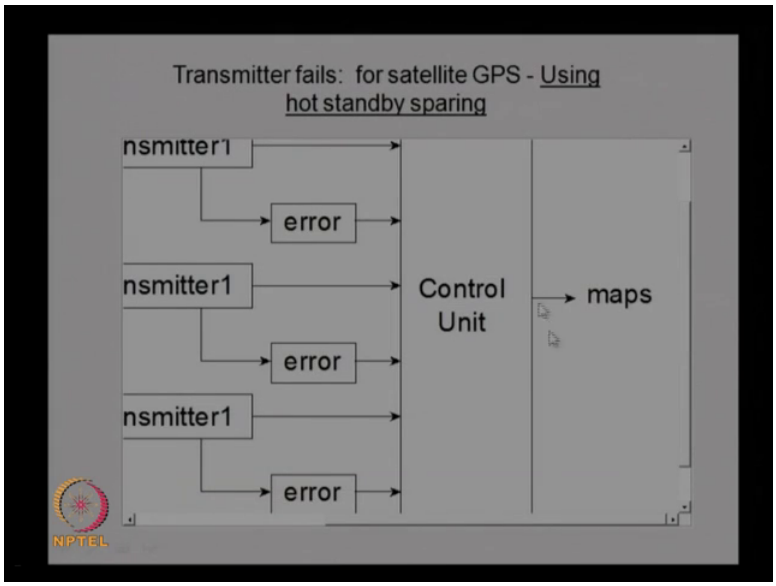


Here I have provided few cases basically for when the transmitter fails or from the satellite GPS data fails and we need to have a hot standby system or hot standby sparing system can be provided to get the signal from the satellite.

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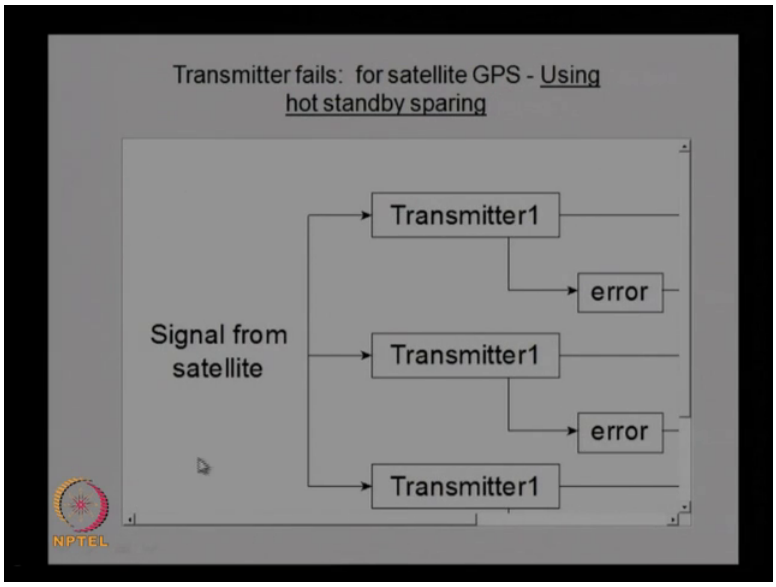


So, we can actually have transmitters more than one transmitter to transmit the signal from the satellite. So, we can have them in the cold stand by the hot standby is basically all these transmitters will be in on condition and there will be an error detector in this one with the specified error declared here. So, based on that this will declared whether there

is an error or not if there is an error in this particular transmitter then automatically data one from this transmitter will be accepted by the control unit and the control unit will given output to the system here.

So, based on these the data will be accepted. So, depending on the health condition of the transmitter the; whichever the transmitter is in good health condition will be used for providing the data. So, that is the hot standby sparing methods.

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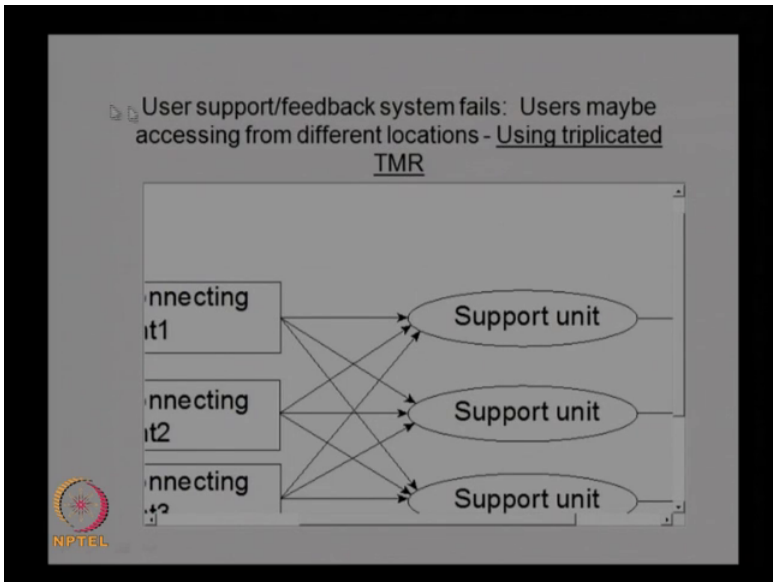


And similarly for the support of feedback system fails. So, we can actually have triplicated TMR kind of method over here.

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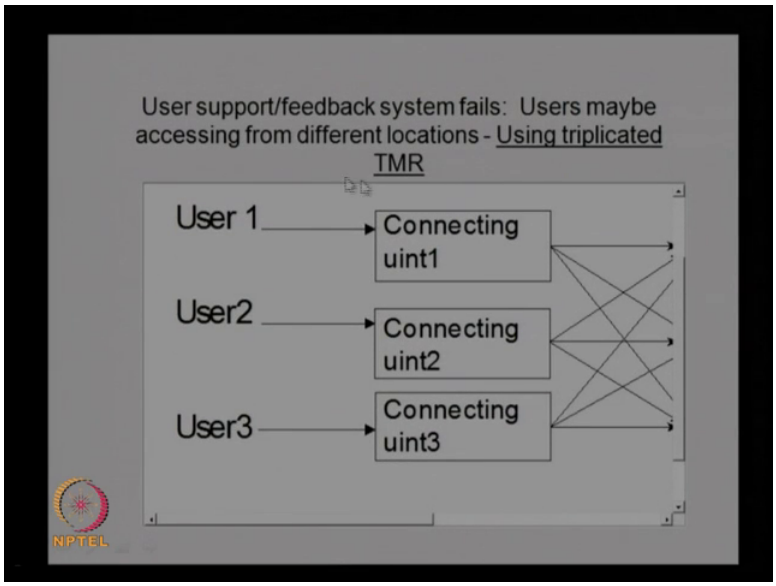


So, when the feedback system fails. So, we can actually have different ways of connecting the user input to the system. So, if one of the method failed other system will be available for connecting; so the user data; if you are using a keyboard or any other interface device; if that with the fails we need to have additional devices to provide the interface. So, we can actually have them in triplicated TMR model.

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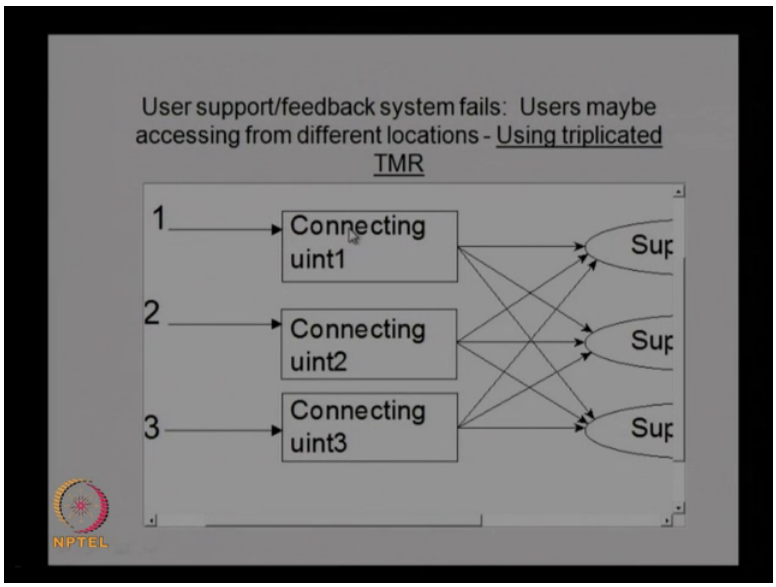


So, that any failure in one of the inputs can always be taken care of using these methods that is A 1 way of providing the standby sparing method.

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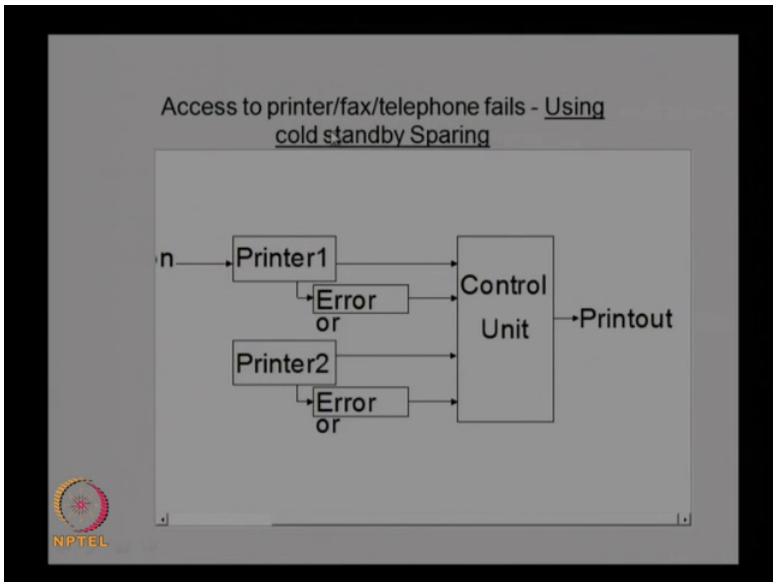


Similarly, for the printer, we can actually have multiple printers in the cold standby mode.

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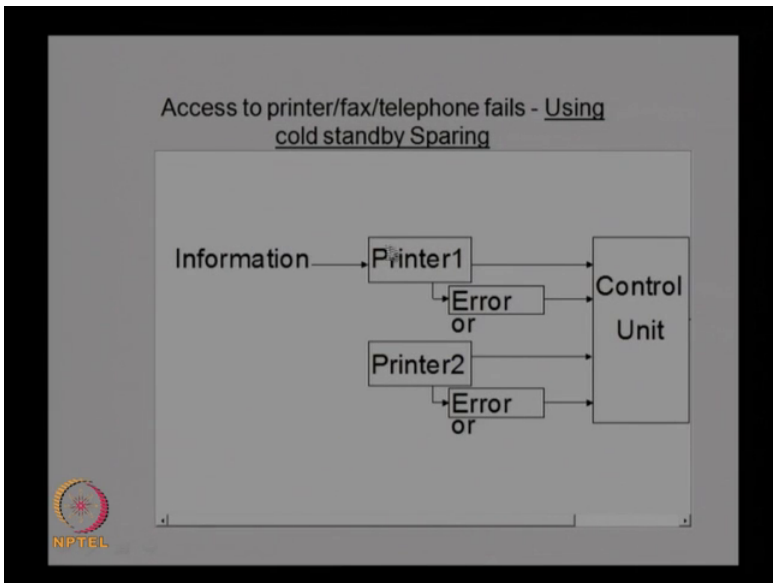


So, we can actually connect to one printer and whenever there is an error this will be actually connected to the printer to automatically it will be redirected to printer 2 though the printer 2 will not be in on mode. So, we can actually keep it in cold standby and whenever needed it can be activated and then can be used for printing the output. So, this

is actually can be in a cold standby because there the time delay in activating this may not be a critical issue here that is why we can have it is in a cold standby methods.

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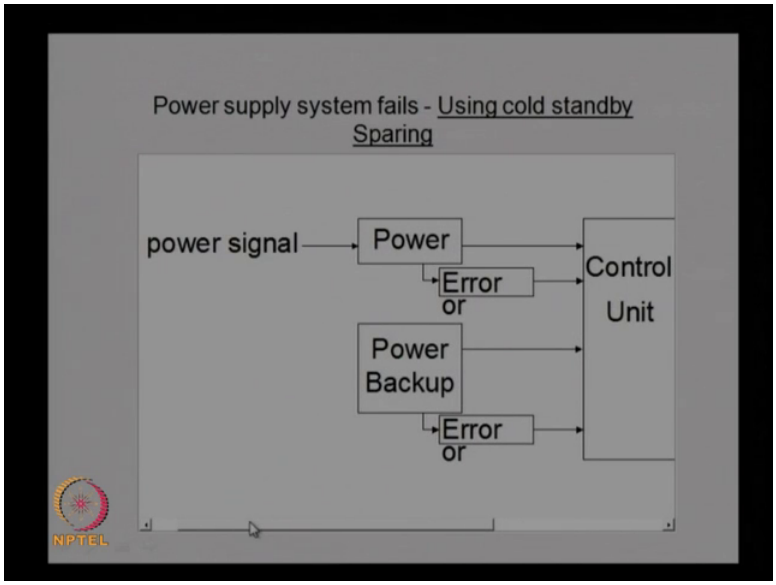


The same way we can go for the power supply system fail also. So, depending on the time required to connect to the backup power we can have it in a cold standby mode or if we it is very critical we can go for a hot standby also, but in this case even if the power fails for few seconds, it is not a major issue. So, we can actually connect in a cold standby we can have a power backup in cold standby. So, whenever the main power fails.

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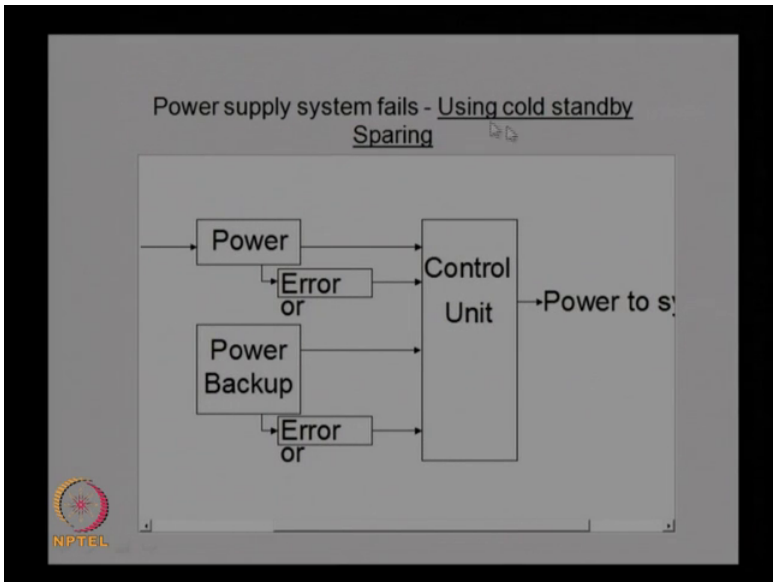


We can actually connected to the backup power and then can be used for controlling the system or you can actually be powering up the system. So, this is a end its a method of providing a standby power supply to avoid any falls in the system or this methods actually provides fault tolerance for the system these actually shows the weightage allocation of the system.

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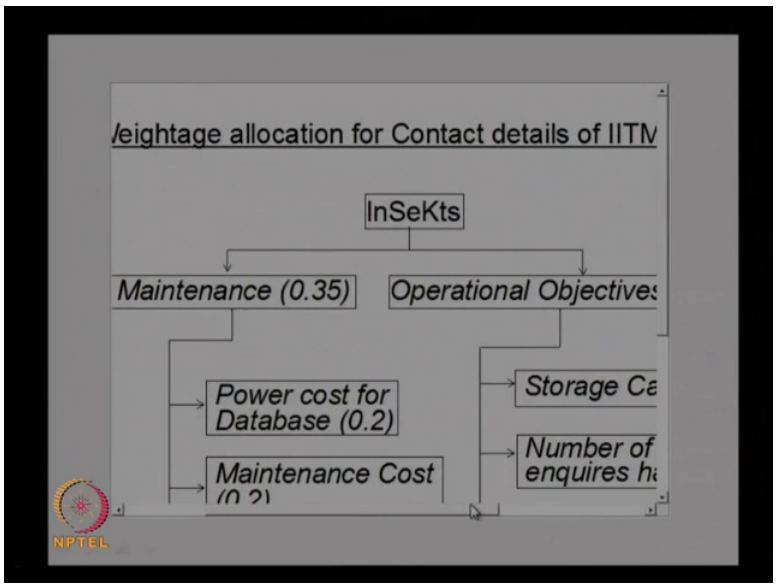


So, we know that there are multiple requirements for the system and then we need to have some kind of priority in assigning the task or assigning the system functions.

So, we can actually see that the operational objectives are given the higher priority over here.

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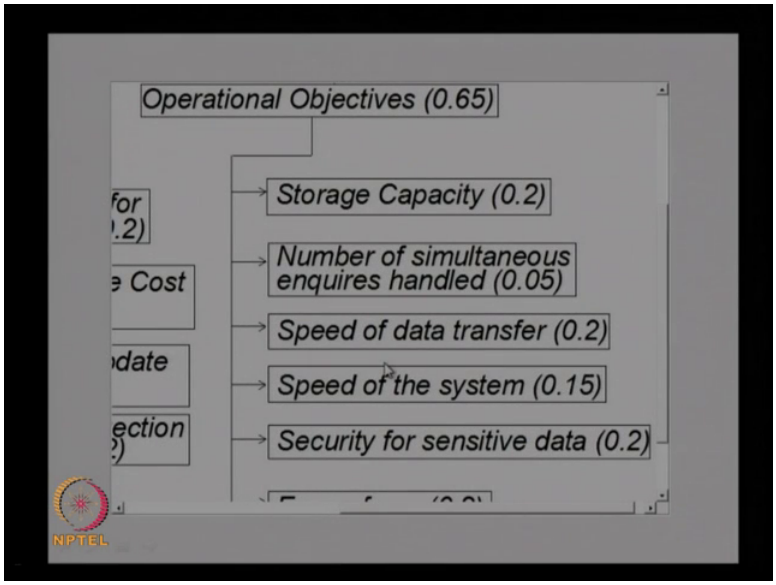


So, 0.65 is given as the priority for operational objectives maintenance is given 0.35. So, this again depends on the designer. So, designer can actually decide which one is more important the maintenance function to be given priority or the operation object is to be given priority. So, these priority operational objectives can actually be again the priorities can be assigned to the subtask in the system. So, here again see that are not up to the operational objectives these are the sub functions needed.

So, again we saw different methods of calculating the weightages. So, using those methods we can actually go for calculation of the weightages for various functions like the storage capacity the number of simultaneous enquires to be handled speed of data transfer speed of the system and security for sensitive data ease of use and this operational objectives the weightage need to be provided to this objectives based on the overall weightage assigned to that particular function.

So, here operational objective is as given 0.65 maintenance is given 0.35 and again the sub functions in the maintenance are given.

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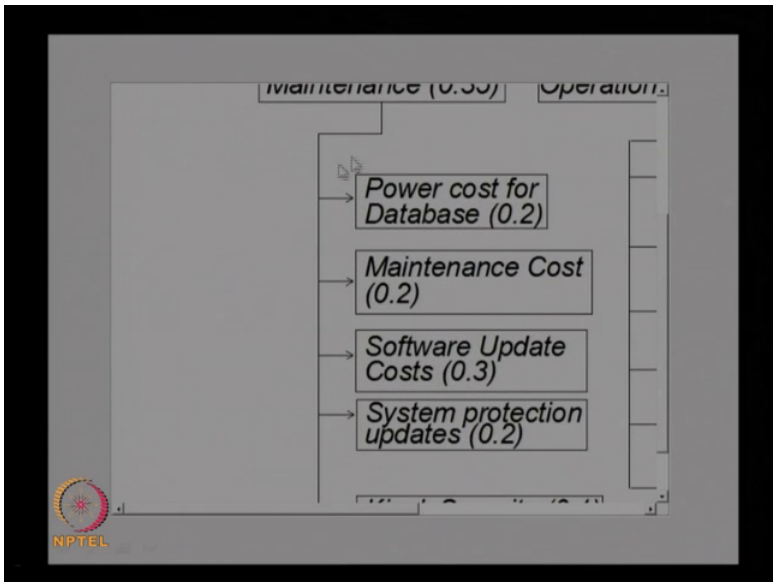


The weightages based on the importance of those functions. So, this is how we provide the operational objectives to the hierarchy of operational objectives and allocation of weightage is to various functions. So, this is actually gives us an idea of how the system design I starts from the initial identification of operational objectives. And then going ahead with the identification of the actual requirements of the system, then identifying the context diagram or developing the context diagram, then looking at the external systems, and then input output requirements, then we go ahead with the complete requirement identification trade off requirements as well as system where technological requirements based on that we develop the originating requirements document.

And then go ahead with the functional decomposition functional hierarchy physical architecture, then other functions for fault tolerance, then objectives and weightage allocation for various objectives trade off, and then we go for the actual system design development of the physical components or selection of physical components, and then integration of these components.

And as we go with this we need to go for the development of testing and evaluation criteria and then once you have the system we do the testing and evaluation and then accept the system. So, that is how we proceed with the design of system. So, all this examples, I am not showing the complete procedure and end to end process get this idea of this is basically to tell you that how to use the principles whatever we learnt in the

system design in a practical situation whenever this is actually a gives you an idea how this can be used for an real scenarios.

So, in order to emphasize this we will take one more exampled again a simple exampled and highlight the importance of various system design principles and use of these principles in the system design.

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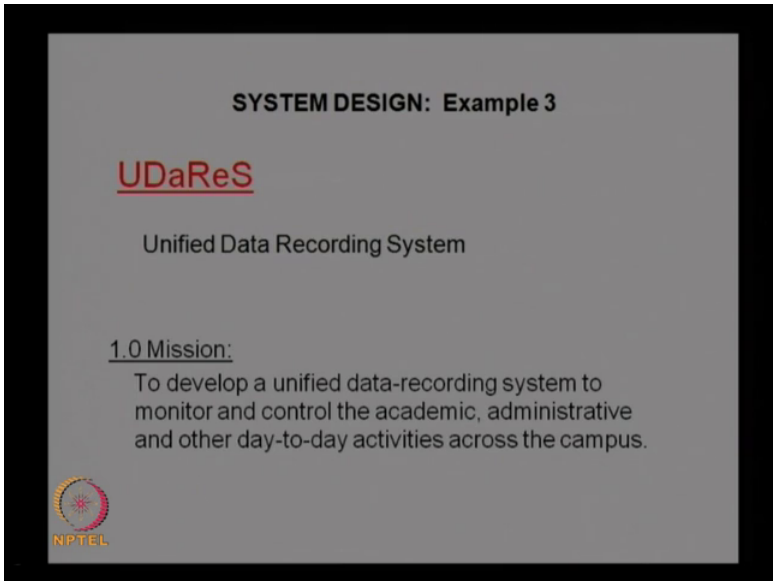


So, this system is defined as or it is named as UdaReS basically it shows that a unified data recording system again, it is a practical exampled which we developed for a practical application the objective of the unified data recording system is basically to develop a unified data recording system to monitor and control the academic administrative and other day-to-day activities across the campus.

Again this is developed for practical application on the campus. So, when we have a unified data recording system which can actually be integrated with various activities of the campus then that becomes a complex system where we need to record lot of data from various sources I like the student attendance the faculty and staff attendance as well as their salary details, then the type of projects taken up by the faculty and all other administrative functions and academic activities like registration of course, this allotment of a slots to the courses then timetable management registration p h t m s and other research project registrations. So, all these things can be combined to a single system where we can have a single database and the various terminals to record the data and

then it is terminals to access the data at various levels. So, here we are looking for a unified data recording system which can be used for various activities in the campus.

We will try to see what are the main objectives and what are the main functions to be provided and then we go ahead with the identifying the difference sub systems and components in order to achieve the these functions.

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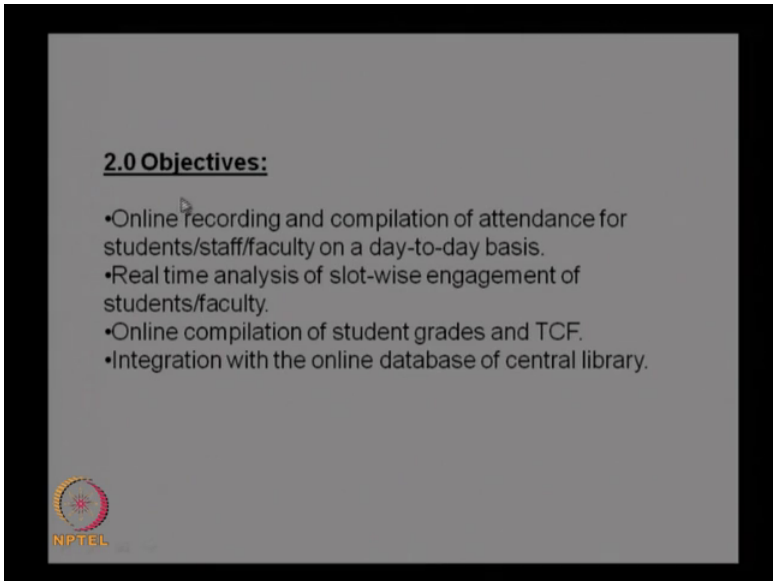


So, as I mentioned the main objectives are online recording and compilation of attendance for students, staff faculty, on a day-to-day basis, real time analysis of slot wise engagement of students or faculty online compilation of student grades and teacher course feedback integration with the online database of the central library.

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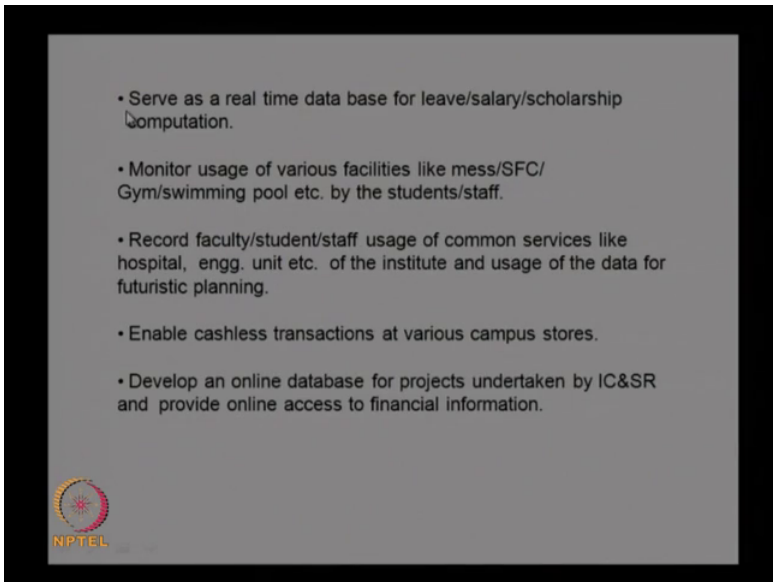


As well as it serves as a real time database for leave salary as scholarship computation monitor usage of various facilities like mess student facility centre gym swimming pool etcetera by the students as well as staff record faculty student staff usage of common services like hospital engineering unit the institute and usage of the data for futuristic planning.

Enable cashless transactions at various camp campus stores. So, apart from the acting as a data storage or recording system you can actually be used as a cashless transaction device also when develop an online database for projects undertaken by industrial consultancy and sponsored research and provide online access to financial information. So, these are the main functions identified for the UdaReS system.

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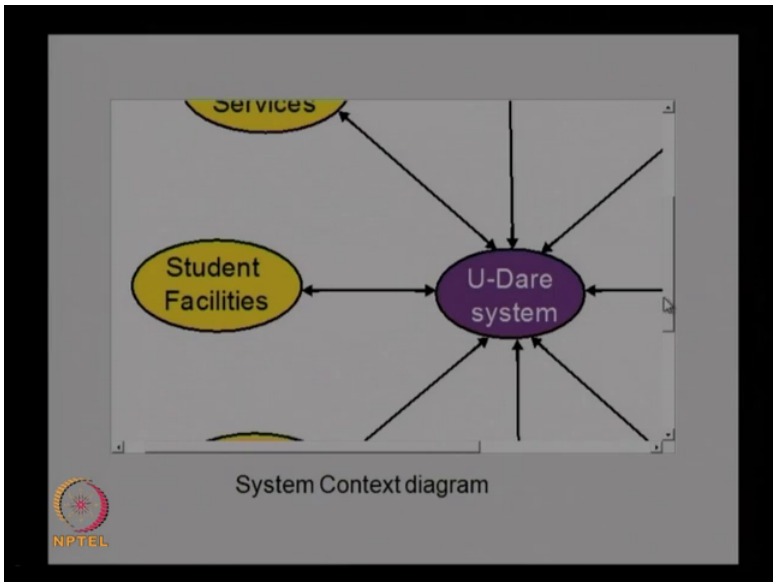


Now, how do you provide these? So, we need to look at the context diagram and what are the various entities which will be interacting with the system. So, if this is the UdaReS system, then these are the external system that will be interacting with it. So, we can see that these are campus services faculty students and stuff.

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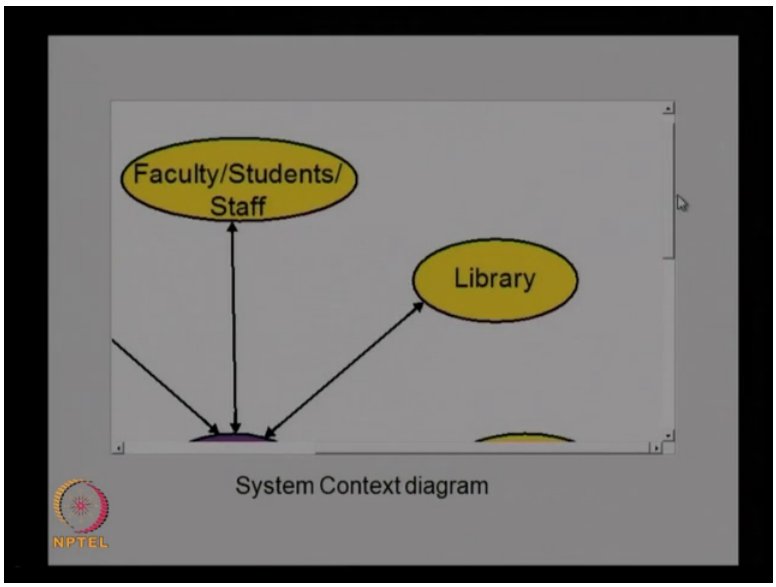


Then a library IC and SR gymkhana and administration of course, the administration includes the financial as well as academic activities.

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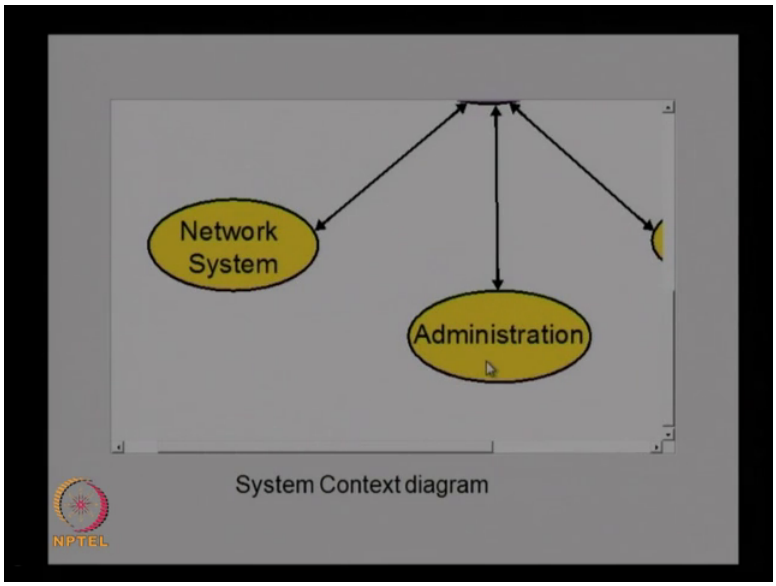


Then the network through which the all the data will be transferred or exchanged with the different agencies or the subsystems. So, that is the context diagram for the U-dare system.

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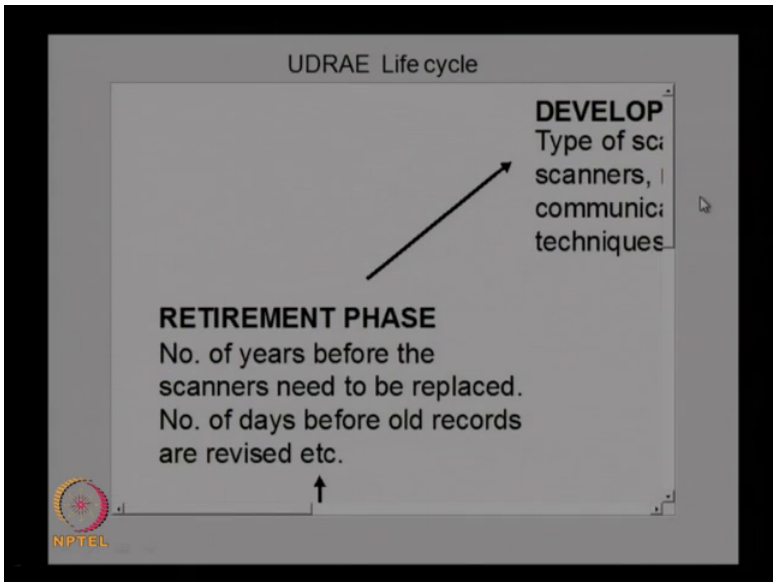


Now, we look at the U-dare life cycle if you want to develop the system, what will be the life cycle of the system.

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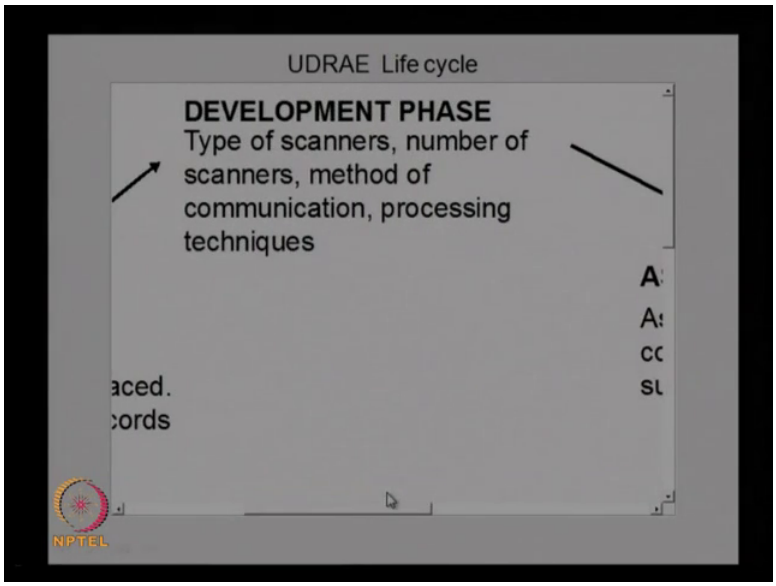


So, in the development phase that is the main phase where we are looking at. So, we need to identify the type of devices and I said scanners basically the type of hardware devices needed for data entry as well as for storing and the locations were we need to provide these scanners. So, the type of scanners number of scanners method of communication processing techniques all these things need to be developed in the development phase.

So, this only a few things now we need to go for many more things in the development phase I like the architecture communication architecture then network architecture all those need to be developed in the development phase.

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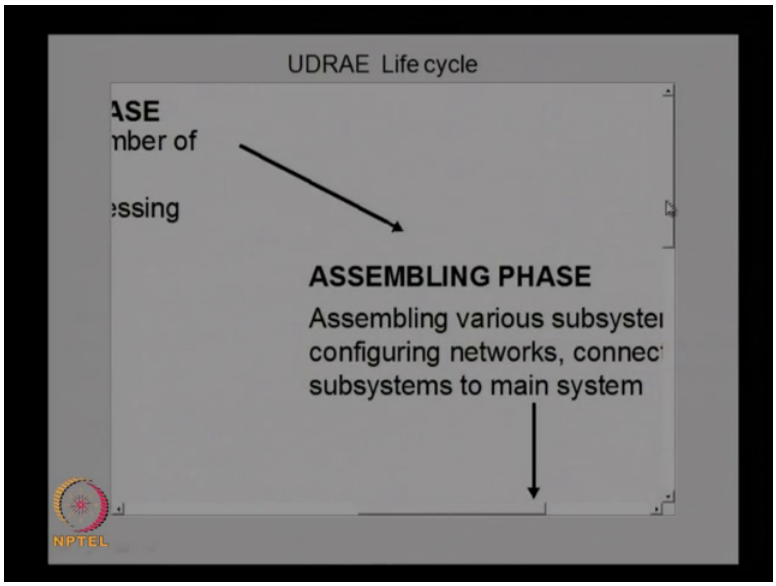


And then it is the assembling or the integration phase. So, we assembled the various subsystems to a main system. So, whatever the hardware we identified we try to integrate them together here if any development new design need to be done that also will be done, then we will do the assembling of various subsystems and configuring of networks and connecting subsystems to main system in the assembly stage.

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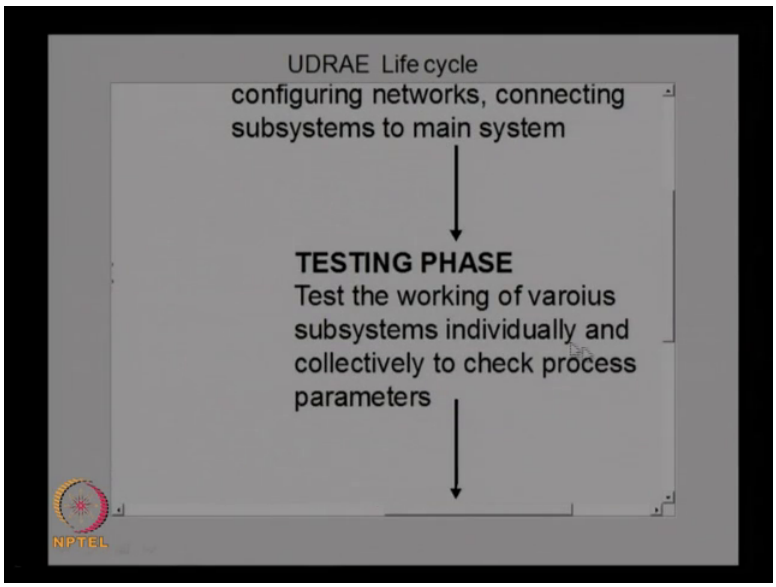


Then we go for the testing here testing the working of various subsystems individually and collectively to check the process parameters. So, we will run for a few days or few

weeks to see whether the system is working perfectly and depending on the output the refinement of the system will take place and once that is done then it will be deployed for operation.

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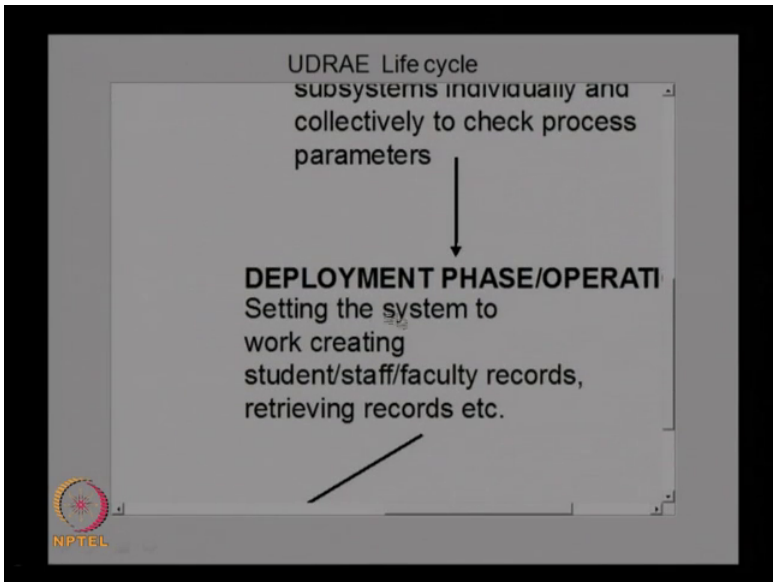


So, then this is the deployment phase of the system and once deployed, then it will be more like the maintenance we need to maintain the system.

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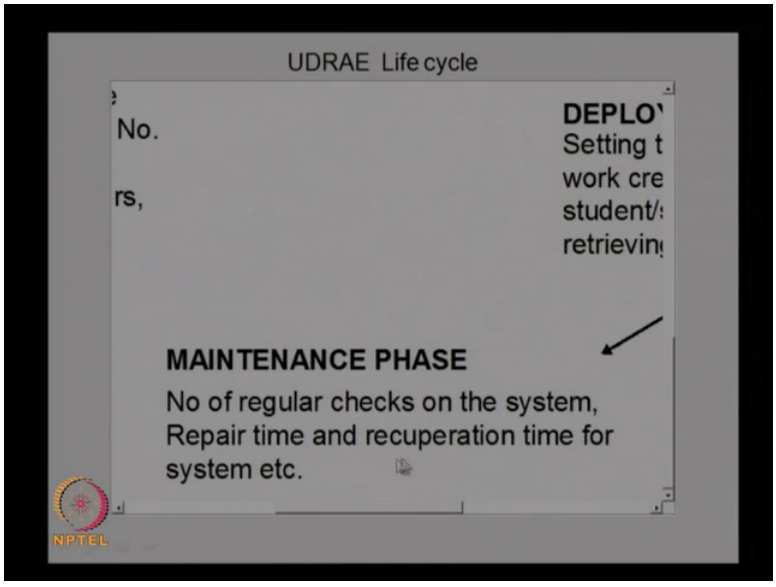


So, the maintenance phase requirements need to be identified what kind of checks to be done what should be the a repair time and recuperation time for a system that is if

something goes wrong how long it will take to come back that is with the MTBF and MTTR and after the maintenance phase basically we will be looking at the refinement.

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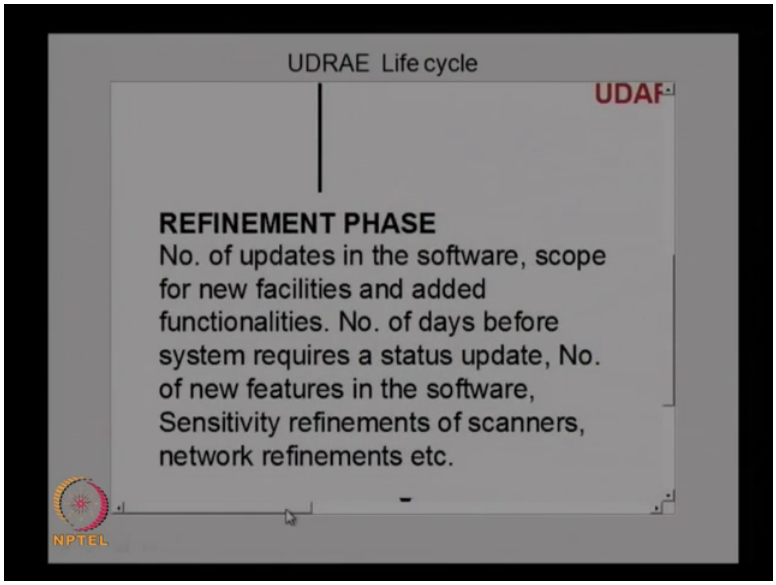


So, what kind of improvement need to be done. So, there any update to be made and what kind of new facilities can be added and what are the features need to be provided for futuristic expansion. So, all those things will be done in the refinement phase and then the last one is the retirement phase, we need to see one actually we have to see the system can be replaced completely or if it we want to replace what should be the process of a replacement; how do we actually a disposed the hardware as well as other components associated with the system.

So, that is the retirement phase. So, when we design the system we need to look at all the phases and then design. So, we will start with the development phase and then we will go through various stages of assembly testing then maintenance then refinement as well as a retirement phase we design the system for all these phases. So, we will not be going all these phases in this example, but I am emphasizing is that it is not only the development phase what we need to be worried we need to look at all these phases when we design the system.

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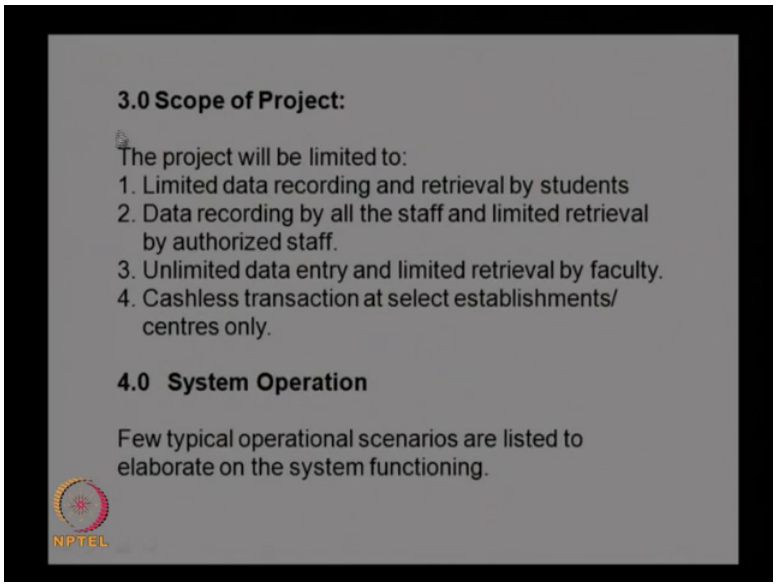


So, here the scope of the project will be limited to the limited data recording and retrieval by students. So, these are some of the project limitations or the constraints, we impose on system. So, the data recording and retrieval by students will be limited that data recording by all the staff and limited retrieval by authorized stuff.

So, all the stuff can actually record the data, but the retrieval will be only limited for to authorized staff unlimited data entry and limited retrieval by faculty cashless transaction at select establishments and centers only. So, these are some of the constraints we identified in the early stage of developments here the system operation we look at the scenarios in how to identify the requirements.

So, as I discussed or explained the previous case studies we need to look at the various operational scenarios in how to identify the complete functional requirements. So, before we start the development we look at all possible scenarios and then identify the requirements. So, we can actually go through many scenarios this in the previous examples also. So, here I will not be going through all the scenarios and explaining how to get the requirements.

They will just take one or 2 scenarios and then show how the requirements can be identified from the scenario.

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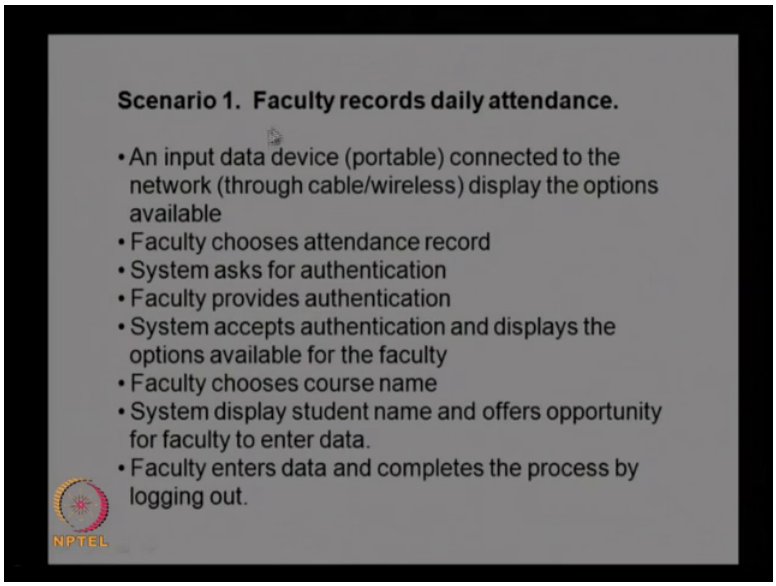


So, here the one scenario is shown as faculty records daily attendance. So, here an input data device connected to the network display the options available. So, that is the first scenario where an input device is provided to the person and it actually shows the options for available. Now this is one scenario and from here we can identify many requirements the one requirement is that a portable device is needed for recording the data. So, it should not be a fixed one it should be a portable one and that should be having a many options displayed. So, there should be a possibility for playing the options in the device itself and it can be a connected through a cabled or wireless.

So, this scenario shows that this is all some of the requirements of that particular scenario then here faulty chooses attendance records then the system ask for authentication and faculty provides authentication and we say faculty provides authentication; that means, there should be a provision to provide the authentication. So, this can be in different ways it can be a password authentication or it can be a fingerprint authentication or it can be some other way of authentication like a swipe card or magnetic cards and then system accepts authentication and displays the options available for the faculty; faculty chooses course name when system display student name and offers opportunity for faculty to enter data and then faculty enters data and completes the process by logging out.

So, this is one scenario were faculty records daily attendance while going through the scenario we can identify many requirements needed for the system. So, the objective of explained in the scenario is to look at this scenario and identify various requirements as you can see here we can identity many requirements. So, if we say that faculty chooses the course name; that means, it should be option should be provided to the faculty or the data base should have all the courses where the faculty is registered. And then all the data corresponding to that course in terms of student name and their roll number should be available then only the faculty can actually record the data and then faculty enters data again need to have some facility for the faculty to enter the data to the system. So, these are all the requirements which can be identified from this particular scenario.

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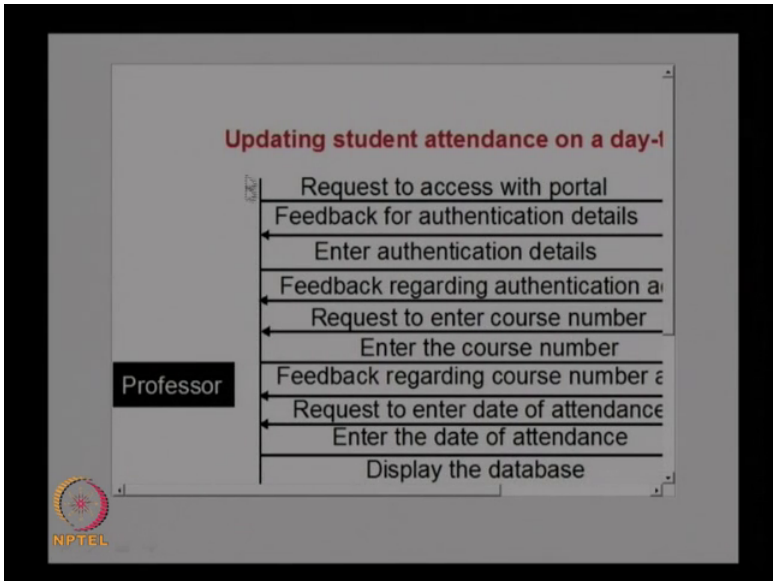


So, we can actually represent the same thing by using an input output trace again we. So, this in the previous examples also; so will identify the external system here.

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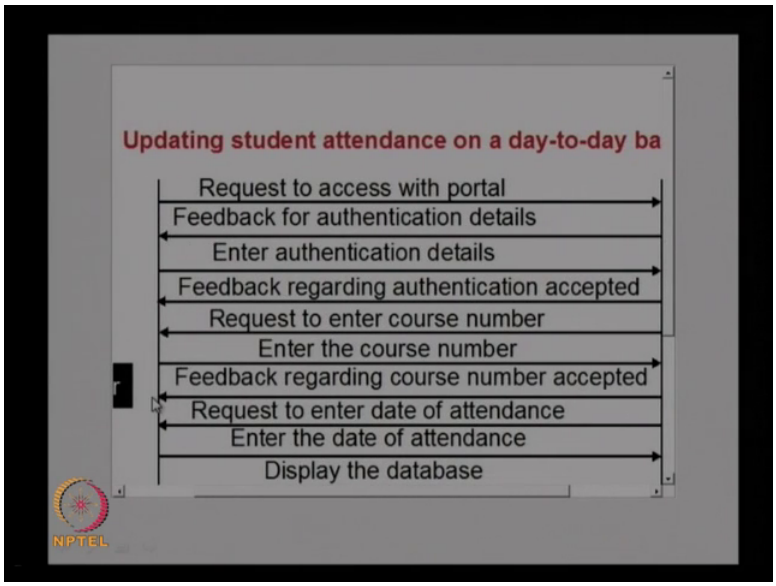


And then the U-dares system as this one and the type of interaction taking place between the faculty as well as the system can be represented here as a inputs and output from the system. So, this will tell you what kind of input is coming to the system and then how do be the system accept that input. So, the request to access with portal; so, what kind of an input is coming and what kind of output to be given can be identified here.

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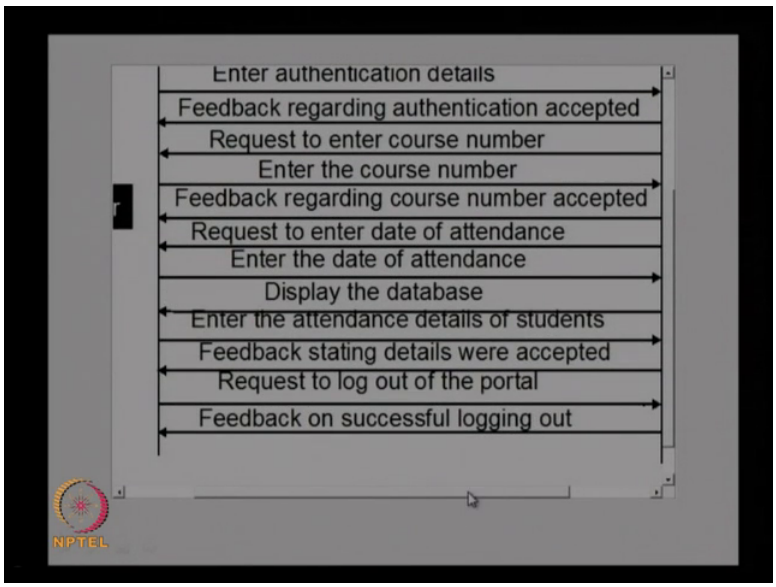


So, same way we can identify all the inputs and outputs and can be shown as a input output trace which will help us to identify the requirements for this particular scenario.

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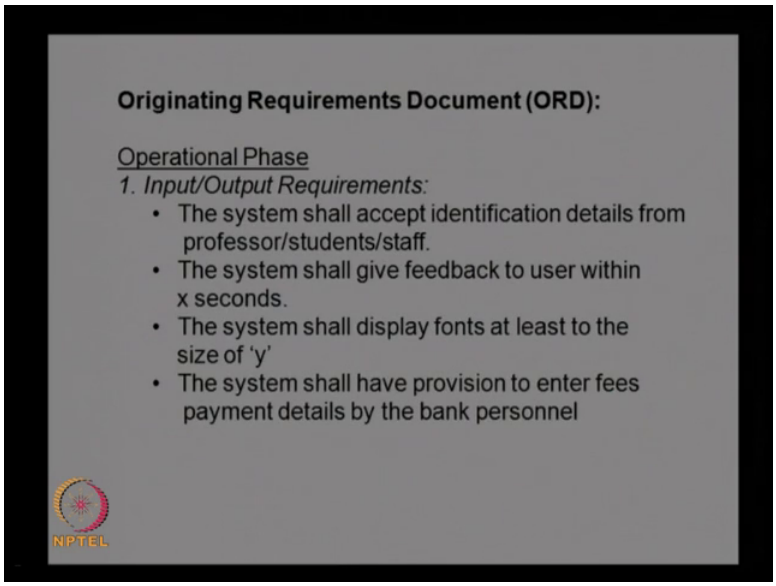


Once we do all these scenarios and we develop these scenarios for various or when we look at the various scenarios and then try to identify all the requirements input output requirements as well as system wide requirement trade off requirement then we tried to develop the originating requirements document. So, originating requirements document will record all the data in a systematic and in a predefined way with some rules and procedures to record the data.

So, this originating requirement document becomes the one of the most important document in the further development of the design. So, we go through all though operation scenarios or the system wide requirement trade off requirements and technology requirements and then record that in the ORD not only for the development phase. So, it will actually consist of all other phases like maintenance then refinement and retirement also.

So, various phases will be considered and all the requirement for these phases also will be recorded in the originating requirements document. So, this is actually shows few requirements identified for the operational phase input output requirements the system shall accept identification details from professor or student staff the system shall give feedback to user within X seconds the system shall display fonts at least to the size of Y the system shall have provision to enter fees payment details by the bank personal.

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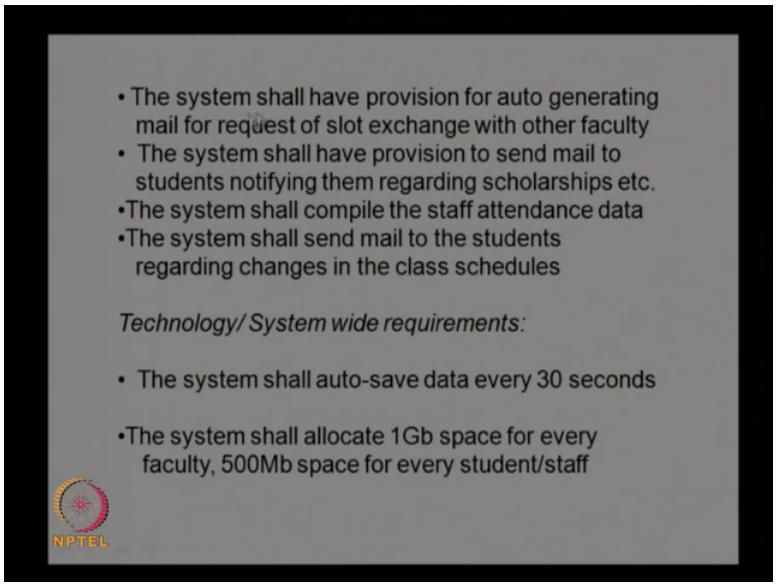


Similarly, the system short have provision for auto generating mail for request of a slot exchange with other faculty the system shall have provision to send email to students notifying them regarding scholarship, etcetera, the system shall compile the staff attendance data the system shall send mails to the students regarding changes in the class schedules.

Of course, these are not complete just a sampled requirements similarly for technology and system wide requirements the system shall auto save data every thirty seconds the system shall allocate 1 Gb space for every faculty 500 Mb space for every student staff of course, this numbers can change, but this actually shows that we need to identify the this requirement also and record it.

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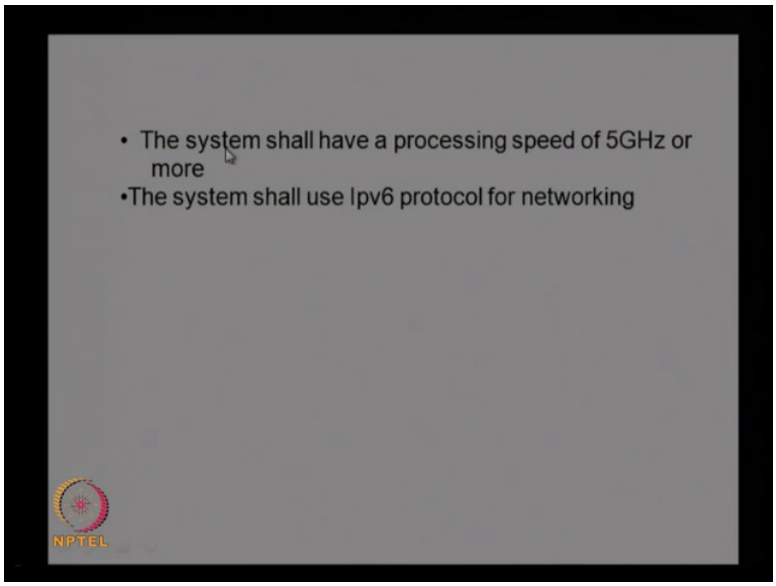


When the system shall have a processing speed of 5 gigahertz or more the system shall use the protocol seeks or more for the networking applications. So, this again these are the technology or the system wide requirements.

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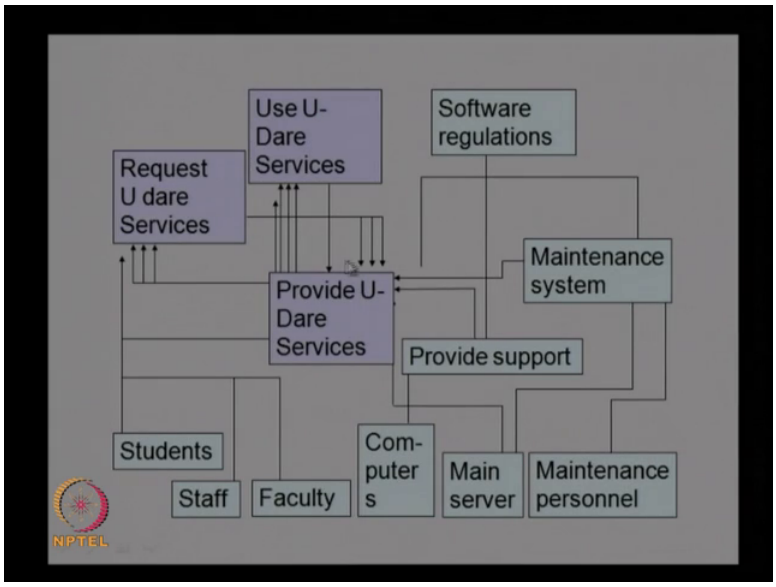


So, we record all these in the originating requirement document and this gives the external system diagram you can have various external systems and how they are interacting with the main system. So, we can see this are the external systems or students staff faculty than the hardware systems then the server maintenance personnel then

maintenance system then there are software regulations then of course, other things like building and other infrastructure also will be coming as external systems and the input will be the request for U-dare services and then output will be U-dare services coming from the system.

So, this is a main system and these are the external systems and this shows the input and output of course, there are various inputs and various outputs coming from the system ok.

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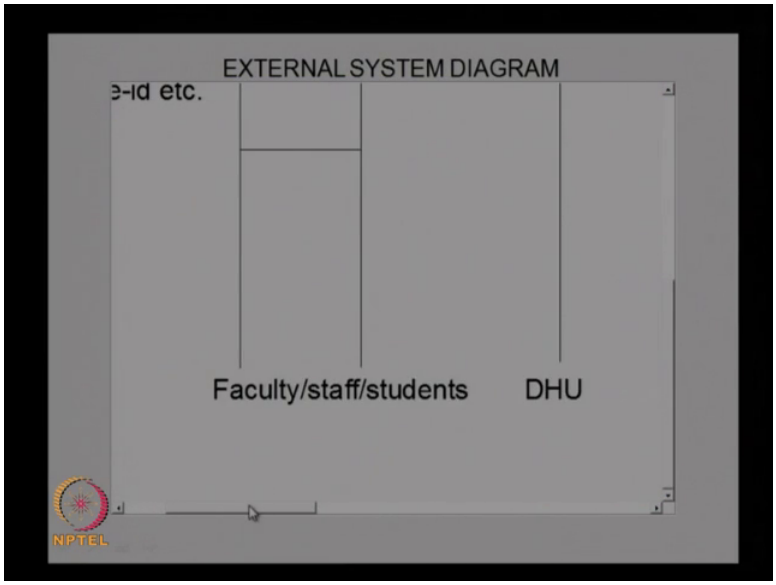


This is actually shows the details of the external system diagram as we showed in the previous one. So, here we can see that faculty staff students are the external systems here.

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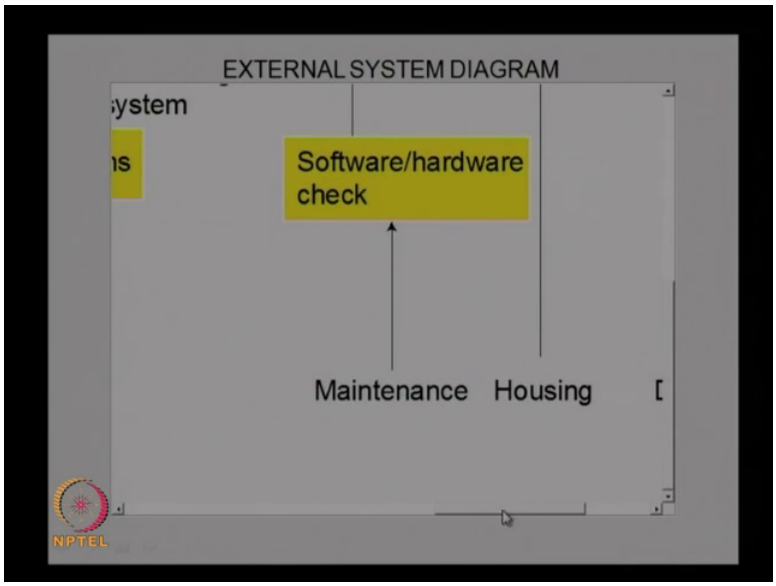


Then the server then administration block staff then maintenance people then the housing or the infrastructure.

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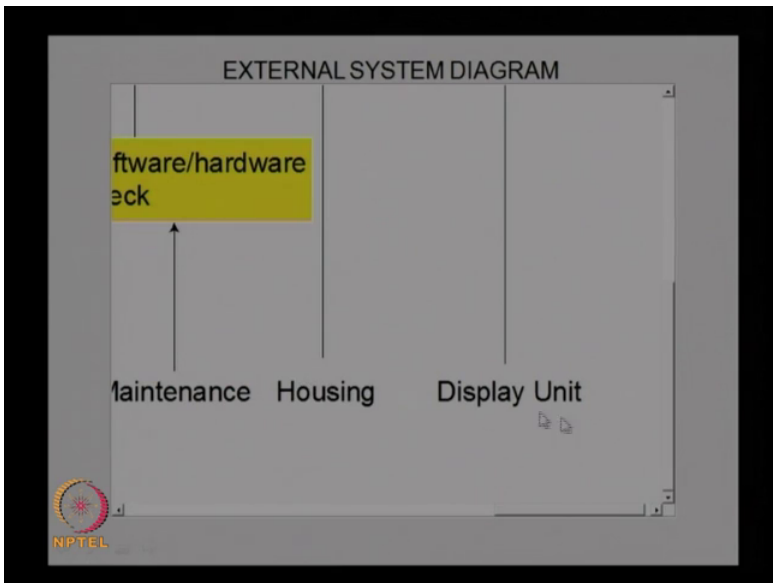


In the display unit, these are the external systems and then you have the main system here which actually provides all the information.

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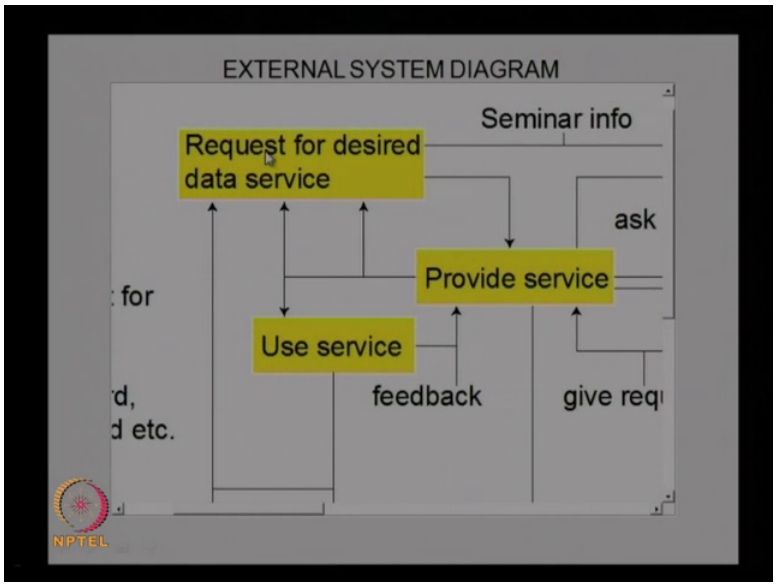


So, here we can see these are the in functions. So, request for desired data service.

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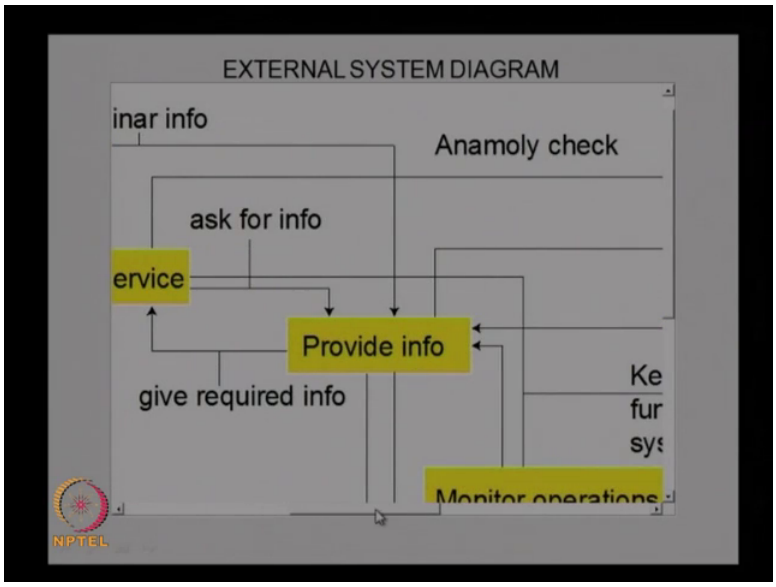


And provide service and provide information and monitor operations.

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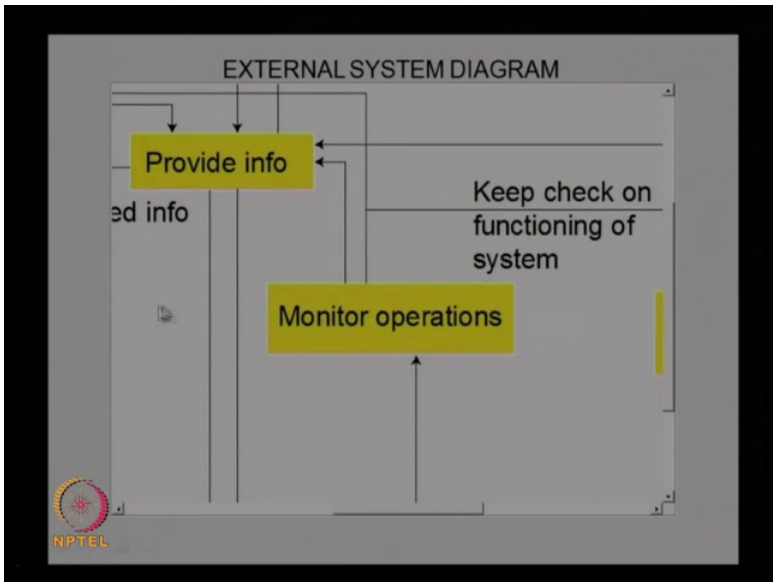


So, these are the functions to be provided by the U-dare system and the all other external systems are shown here and the type of interaction with external systems also shown over here.

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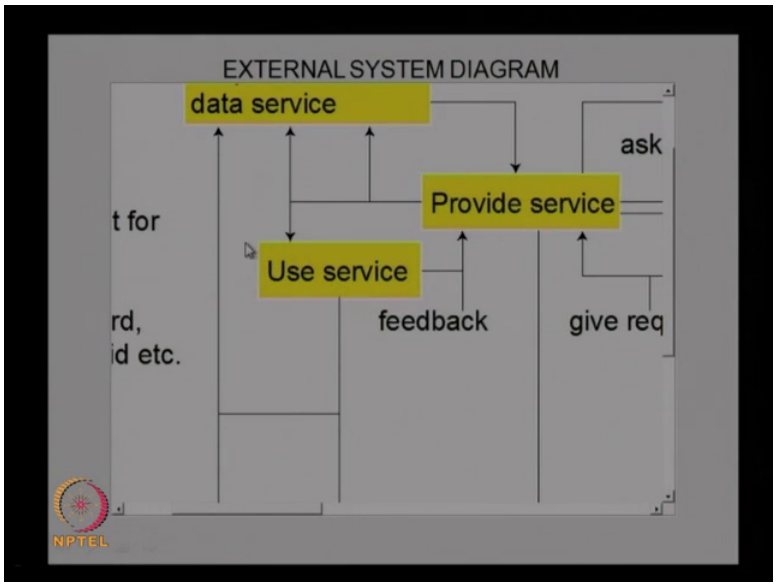


You can see that the inputs and outputs from various functions are shown here in this diagram ok.

For functional decomposition we saw this in the previous examples. So, we start with the A 0 context diagram we identify all the inputs and outputs.

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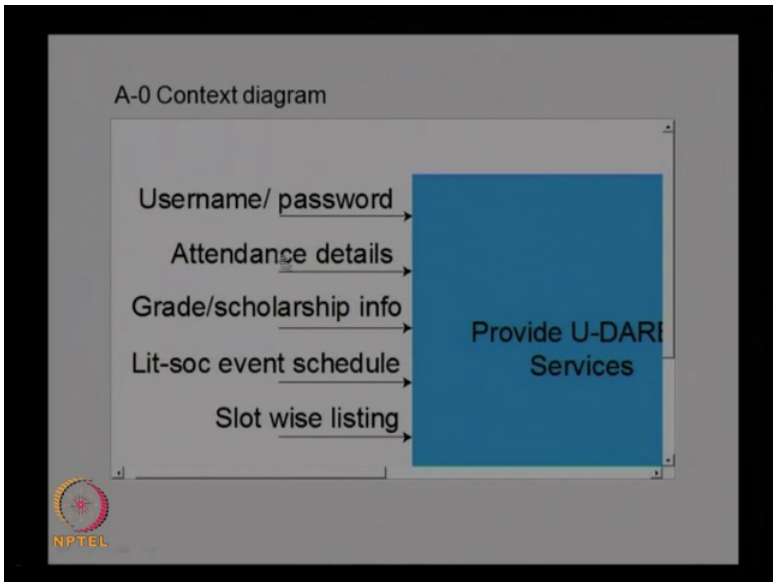


So, these are the inputs to the system and this is the main function of the system providing U-dare services.

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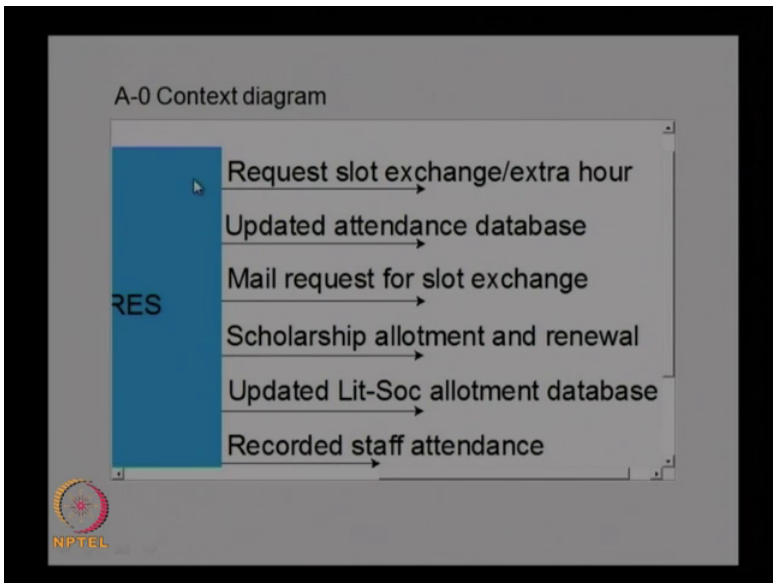


And this actually shows the outputs what kind of output is coming from the main system. So, the request all the outputs, but or we discussed in the previous slides. So, updated attendance like database mail request for slot exchange scholarship allotment and updated the databases, then staff attendance fees database all this will be given as output from the U-dare services.

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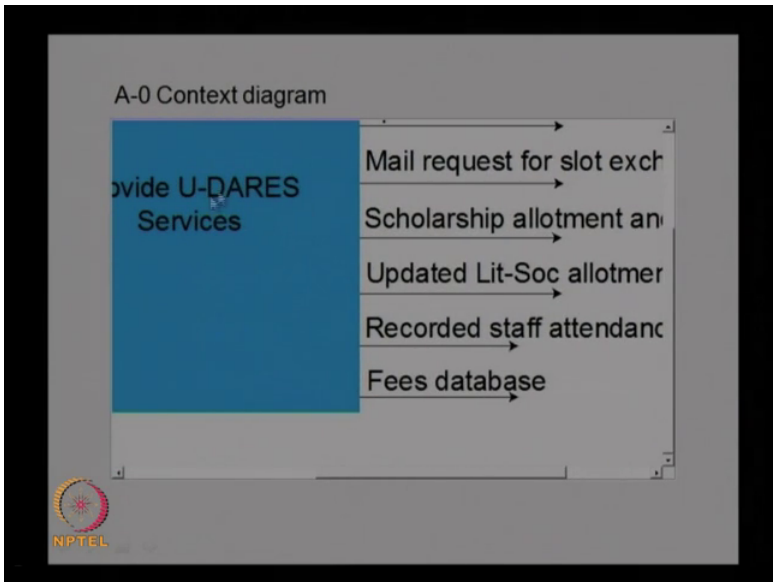


You can actually go for further decomposition using the IDEF0 diagram as we explained in the previous cases also you can this A 0 function can be divided into A 1 function A 1, A 2, A 3 functions like this.

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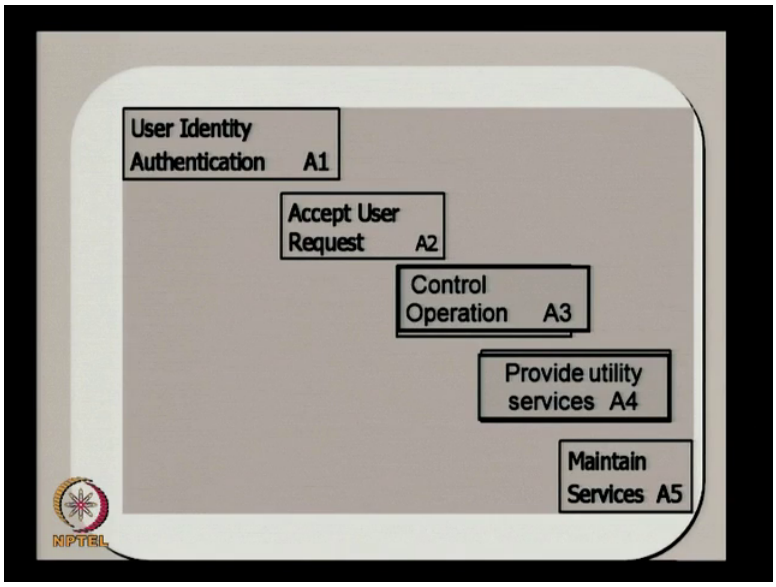


So, these are the sub functions; we need to provide like user identity authentication accepting user request.

Then control operation, then provide utility services and then maintain services.

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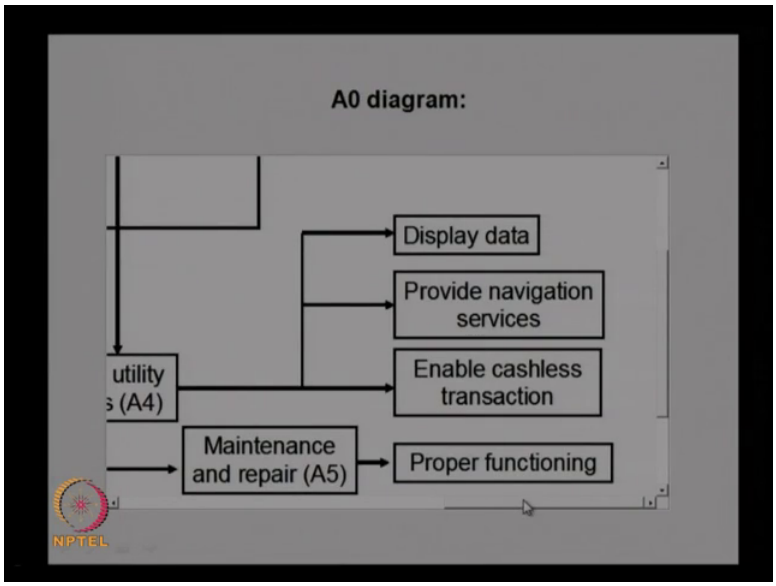


So, here you can see the detailed A 0 diagram. So, these are the sub functions.

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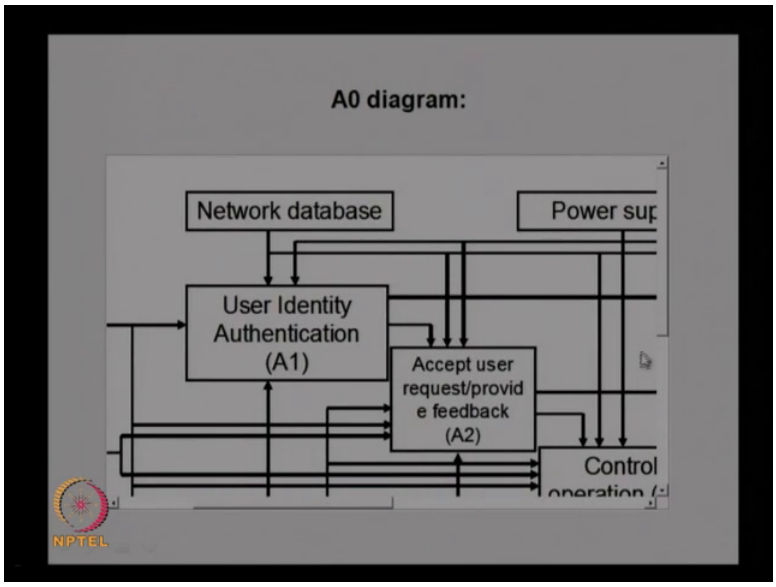


A 1, A 2, A 3 and A 4; A 1, A 2, A 3 control operation then A 4 is provide utility services then maintenance and repair.

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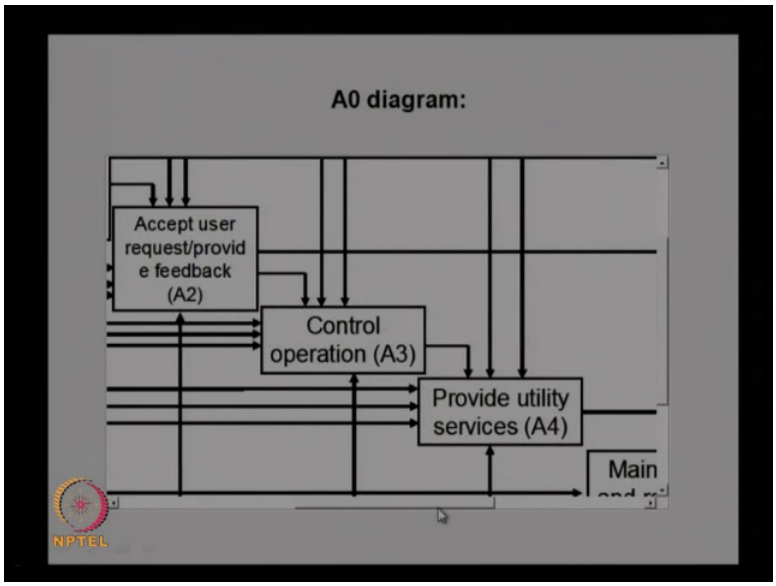


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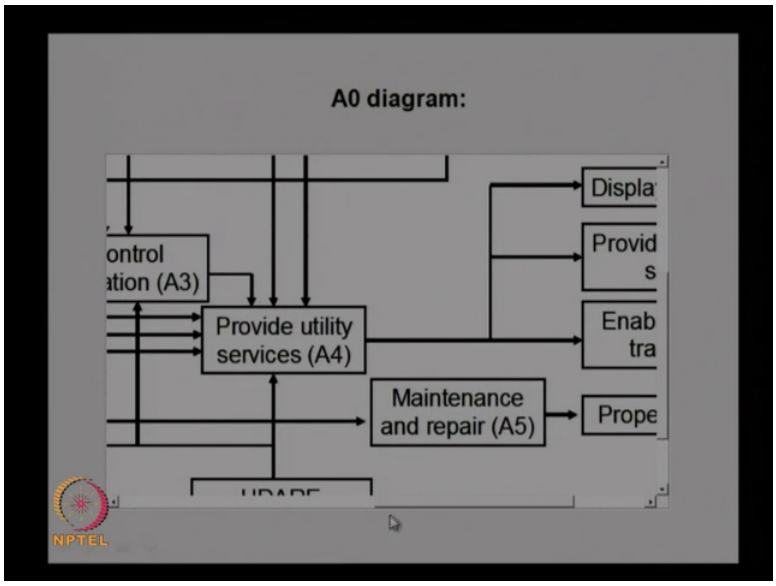

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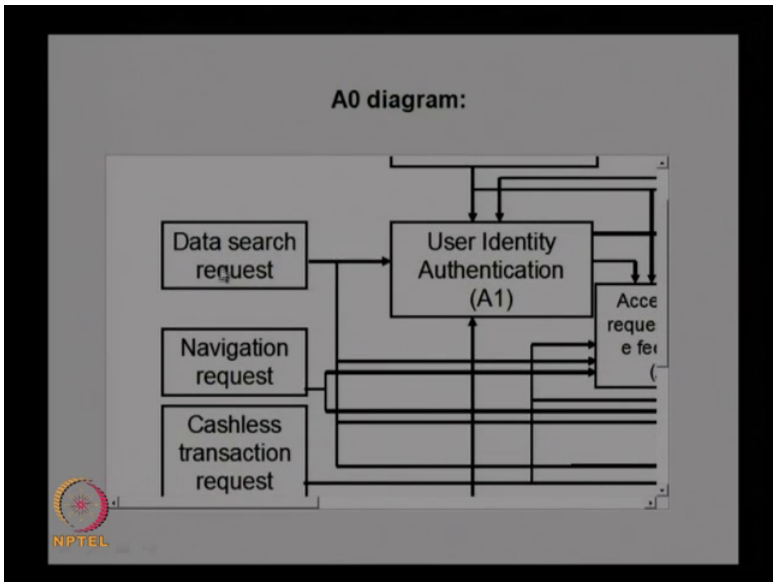


So, these are the 5 sub functions need to be provided in the system and their interactions are also shown what kind of interactions are taking place you can see; there are different inputs coming to the system that are request navigation cashless transaction request and other services and for that one; we need to provide all the this inputs will be going to this functions and then the input will be process and the output will be provided over here.

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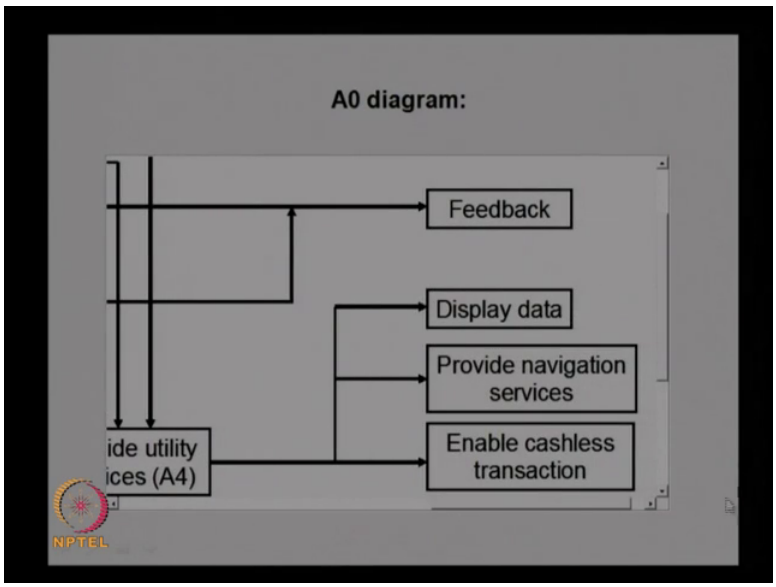

So, that is the output from the first level diagram or A 0 diagram and then we have the further decomposition you take A 3 function A 3 function can be decomposed into A 31, A 32, A 33 functions.

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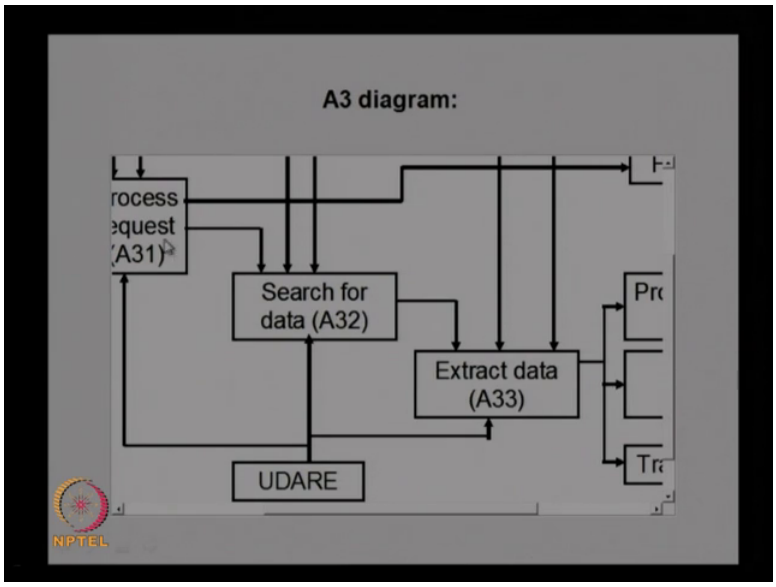


And then we and see that these are the process request search for data and extract data are the sub functions.

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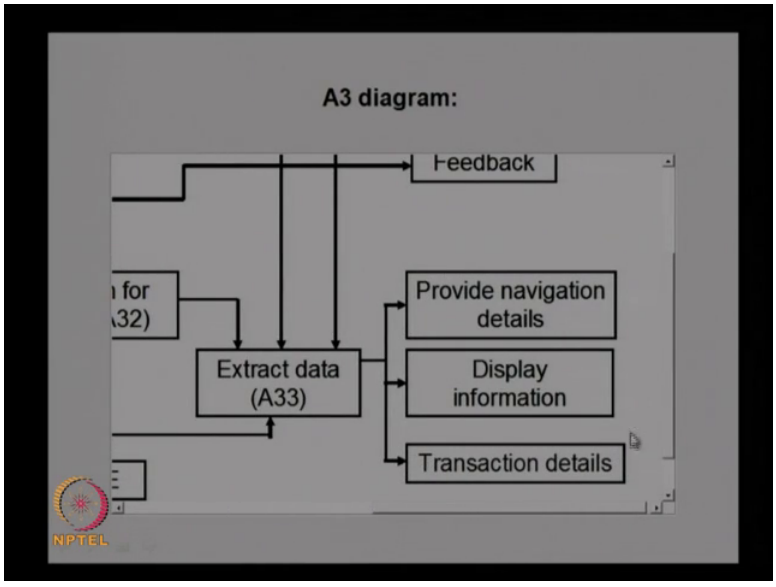


And again the output from this will be the details information transaction details then feedback.

Similarly, you have the data search request and cashless transaction request and other request for coming from the customer. So, these functions process; these data and give an output. So, this is the way how we actually go ahead with the height of 0 decomposition of functions and this shows the decomposition of A 32 function.

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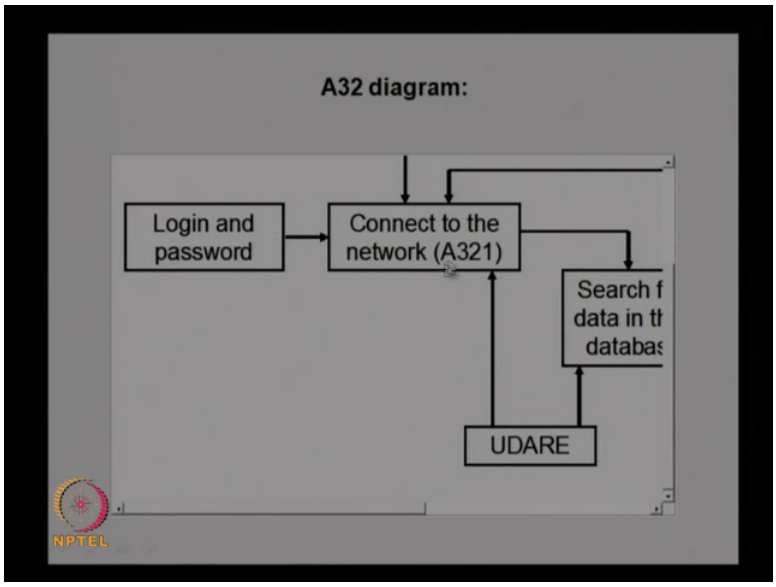


So, A 32 function the input is login and password, then it connect to the network search for decide data.

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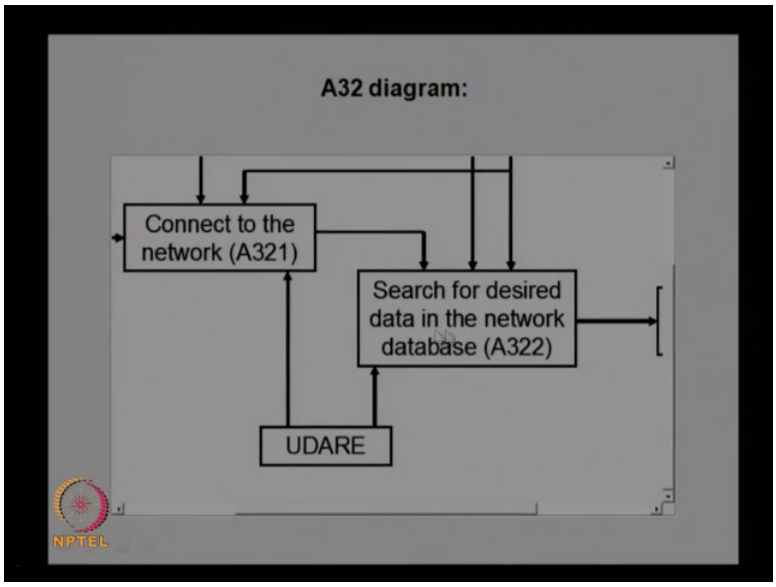


And the network database and then provide the data output.

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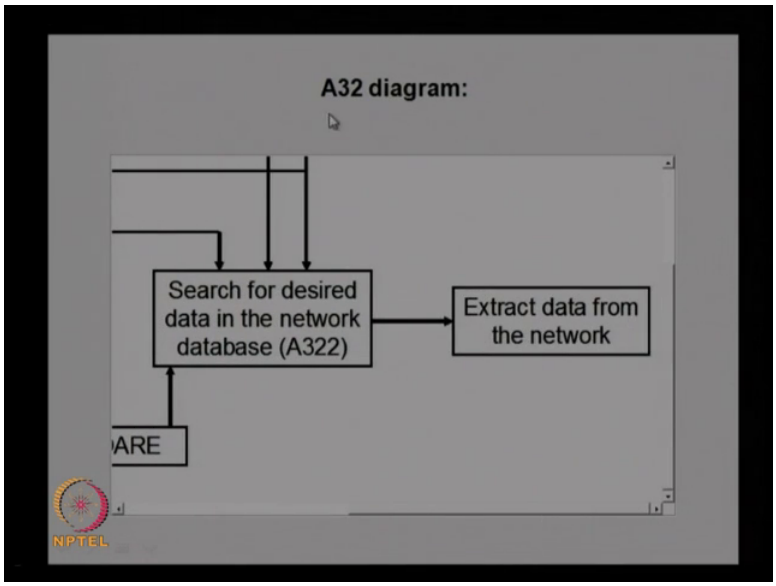


So, A 32 will be having 2 sub functions A 321 and 322 and that will be providing the extracted data from the network to the next function.

This is the 332 diagram. So, here actually this 332 function is decomposed further find the category of information ask by the user then collect data from the corresponding category and extract the data it as an output.

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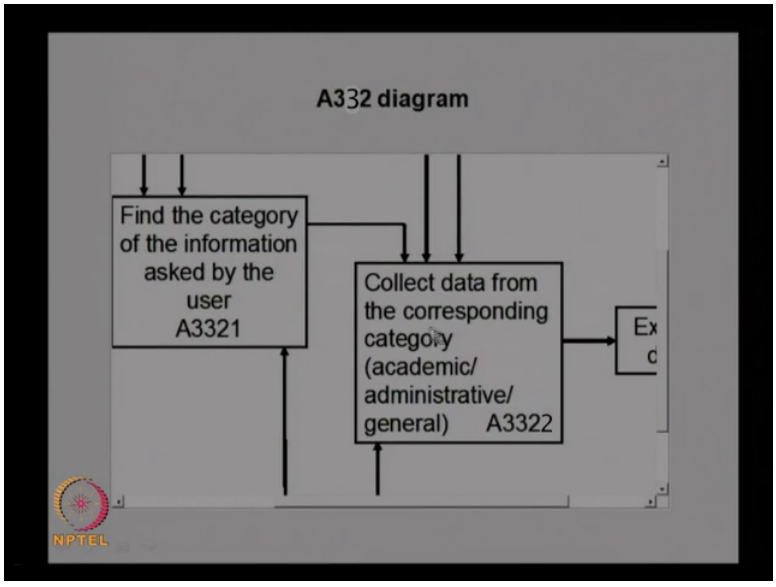

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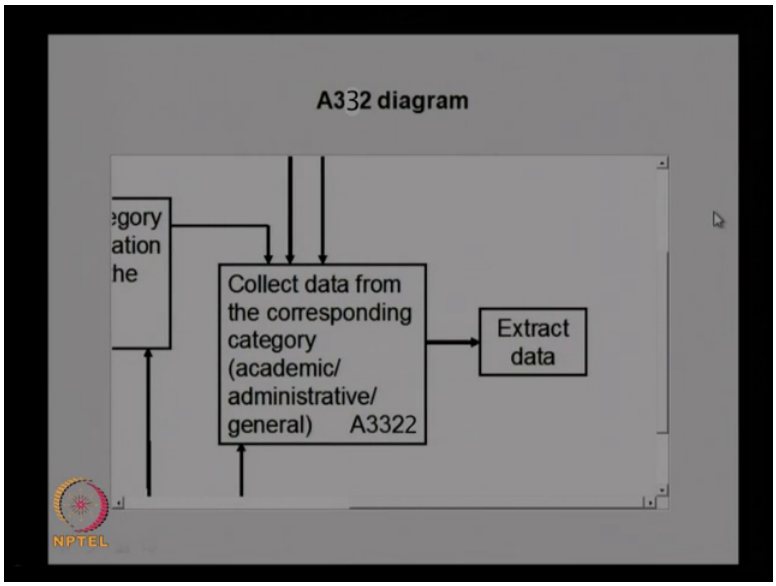


So, once we have all these functions, we try to prepare it as a functional hierarchy diagram.

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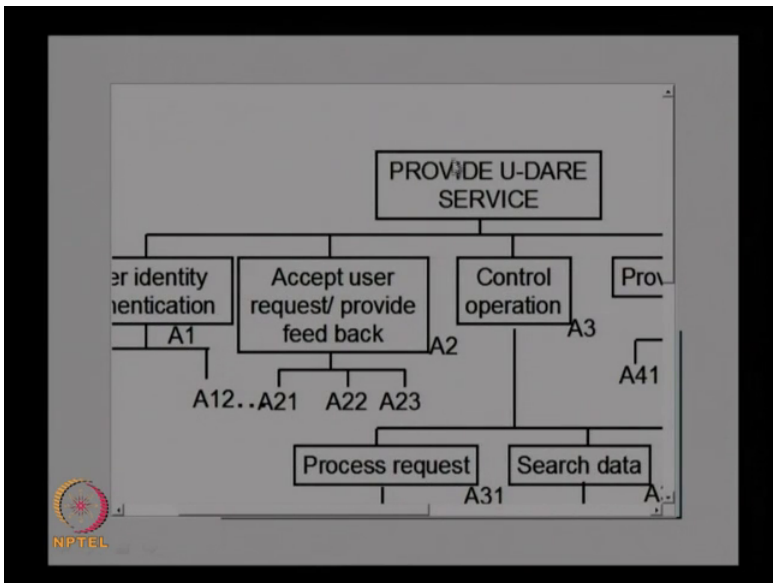


So, we will provide the top level function over here provide U-dare services and then write down or the sub functions identify user identity authentication accept user request feedback.

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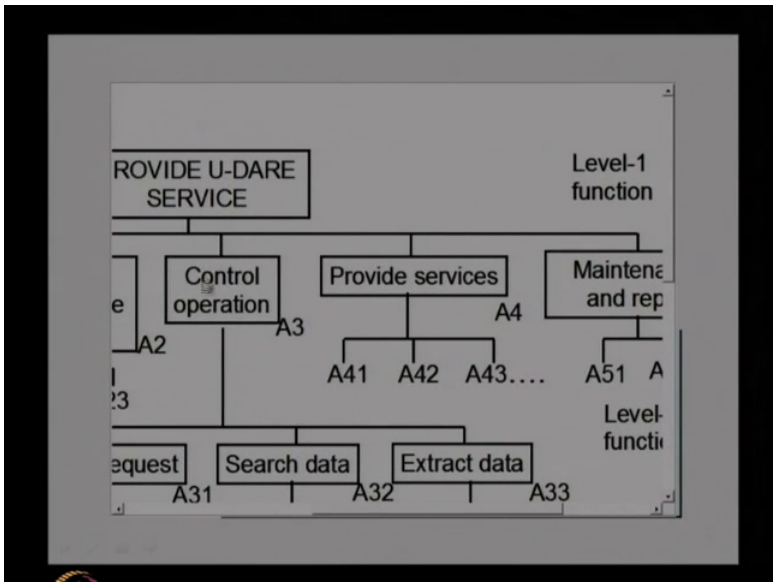


Then control operation provide services and maintenance and repair and therefore, all these function will be having sub functions identified through the IDEF0 diagram. So, we will take the one example here A 3 and for A 3, we have many sub functions identified A 31, A 32, A 33 and then again A 3 to has been decomposed further to A 321, A 322 and again A 322 is decomposed into A 321 322 like that.

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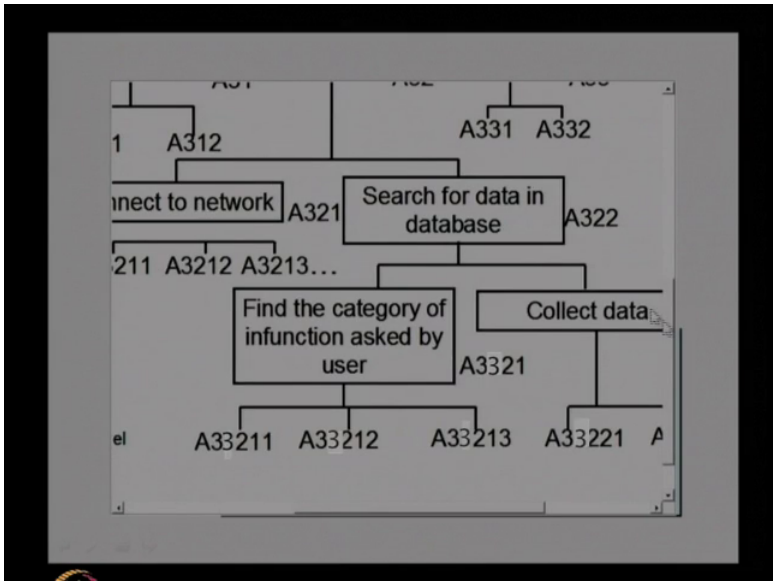


So, all these functions can be shown as a hierarchical way it will give the functional hierarchy of the system and based on the functional hierarchy, we can develop the

physical architecture this shows the weightage allocation for various functions in the system.

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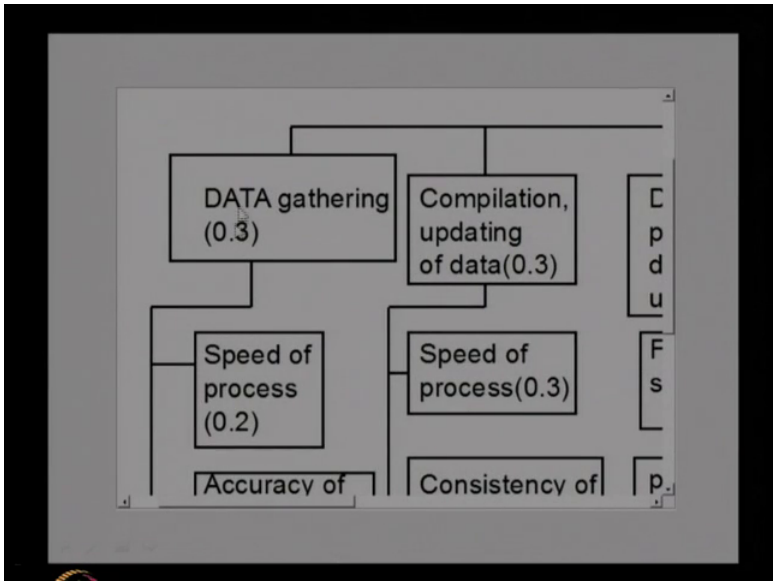


So, we can actually see here this is a data gathering is given a weightage of 0.3 compilation and updating of data given a weightage of 0.3 again then display 0.2 and that the other features 0.1.

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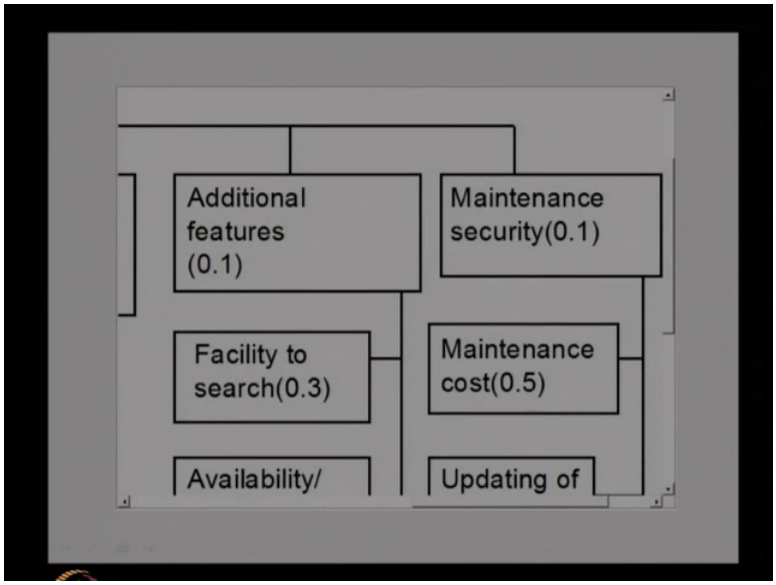


And maintenance is given a weightage of 0.1. So, these actually helps us to have the hierarchy of functions and then there weightages you know to have some kind of a trade

off at a later stage in the design and again each one will be having sub functions and depending on their importance it will be given weightages accordingly.

So, here we can see this particular data gathering is given a weightage of 0.3 and within that there are many functions like speed of process accuracy of data gathered and maintenance of gathering devices.

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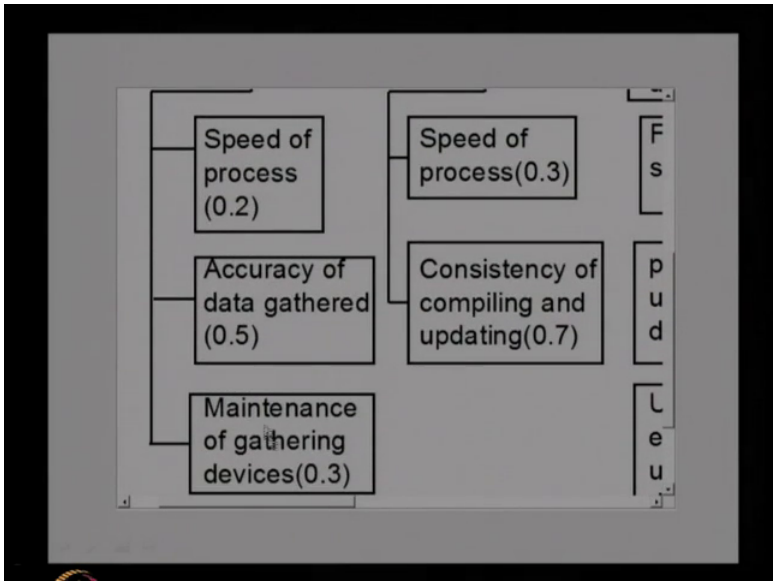


So, these I have been given the weightages 0.2, 0.5 and 0.3; again there are mathematical methods to identify the weightages. So, we use those mathematical methods and identify the weightages for each function the same way it is given for these one also speed of process and consistency of compiling and updating.

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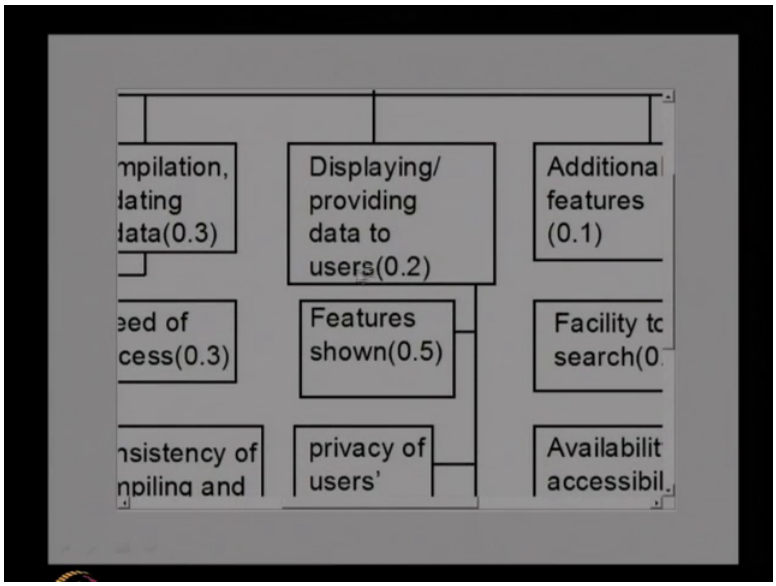


And here it again displaying the data to users has got features shown and then the privacy of users and users ease of using the display.

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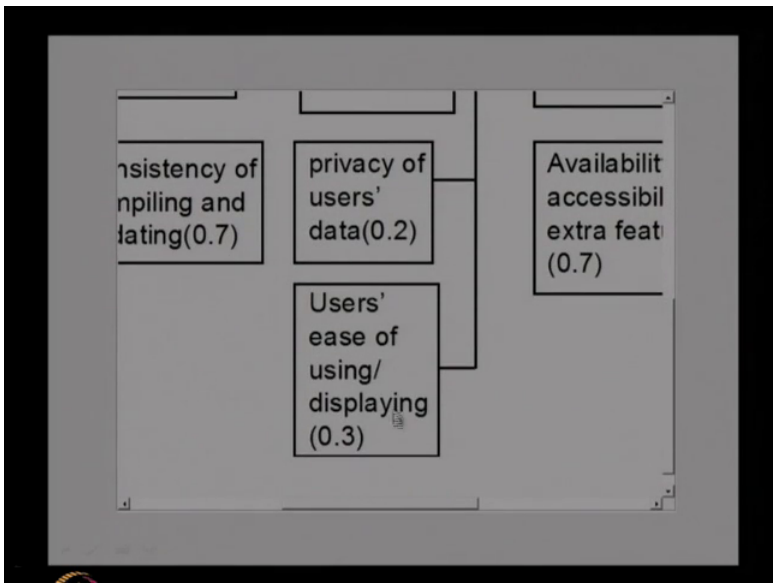


Again weightages are given accordingly. So, these are weightages allows us to have the trade off at a later stage if you want to modify the design or we want to have some kind of trade off.

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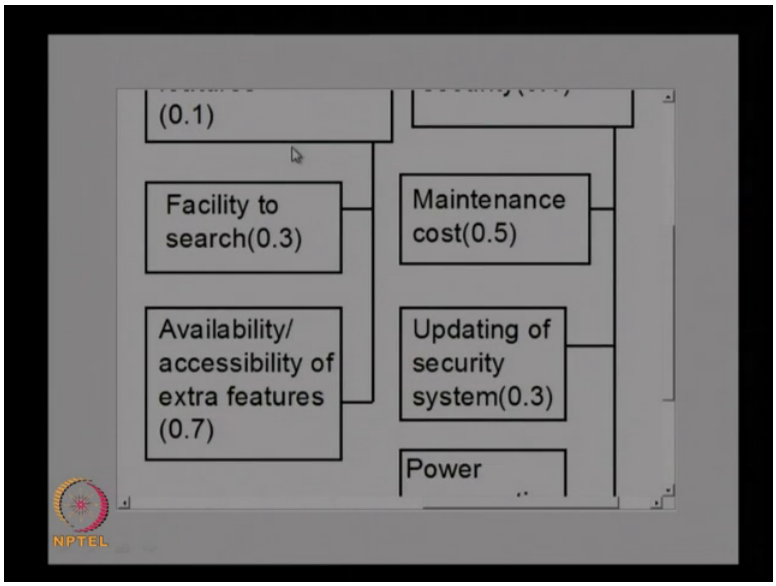


So, that is about that trade off then here it shows the morphological boxes.

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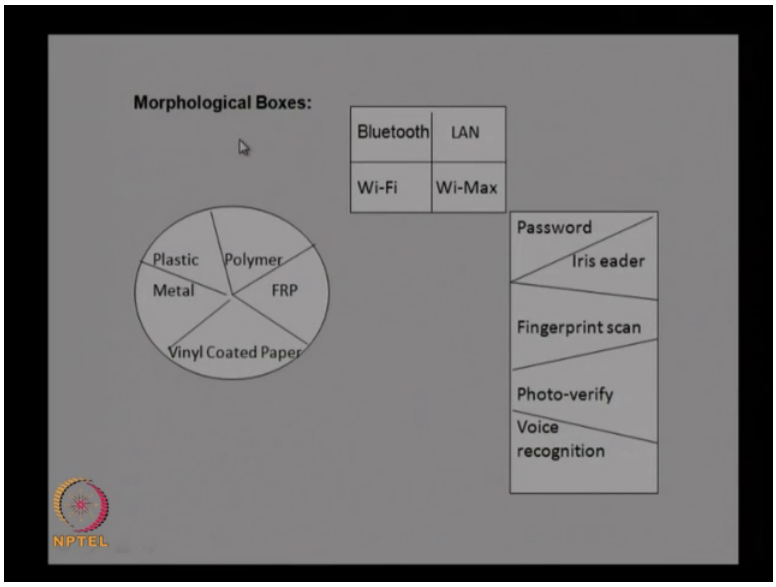


As I told you about the physical architecture development in order to have the instant treated physical architecture we will try to identify the various options for input and output these are all functions. So, this actually shows different options for various functions here.

So, this is one function where you can have the user authentication. So, you can use password iris eader or fingerprint screen or photo verification or voice recognition and

similarly for networking you can actually used for a Bluetooth or LAN or Wi-Max or Wi-Fi and for the authentication we can use the plastic cards or vinyl coated paper or a FRPs input devices.

So, these are the options are shown for various functions and we can choose any one of these and make a combination of this to get the instantiated physical architecture.

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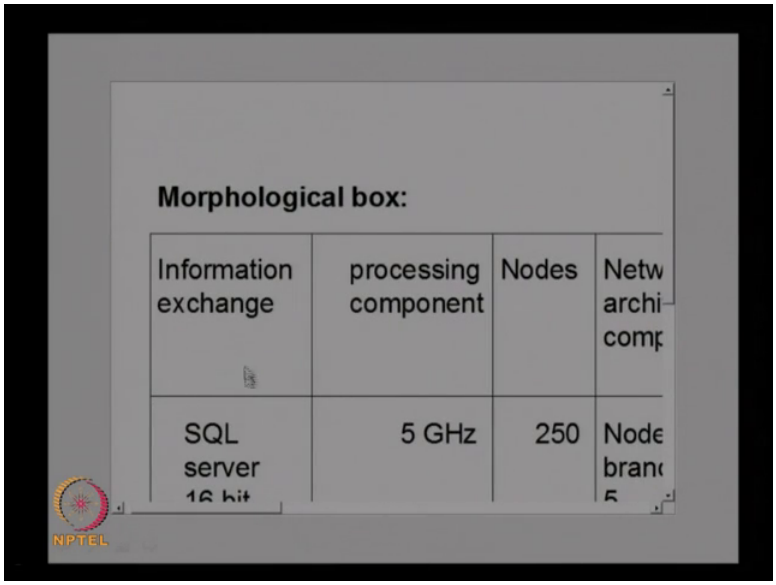


This shows the morphological box for various components for information exchange processing component.

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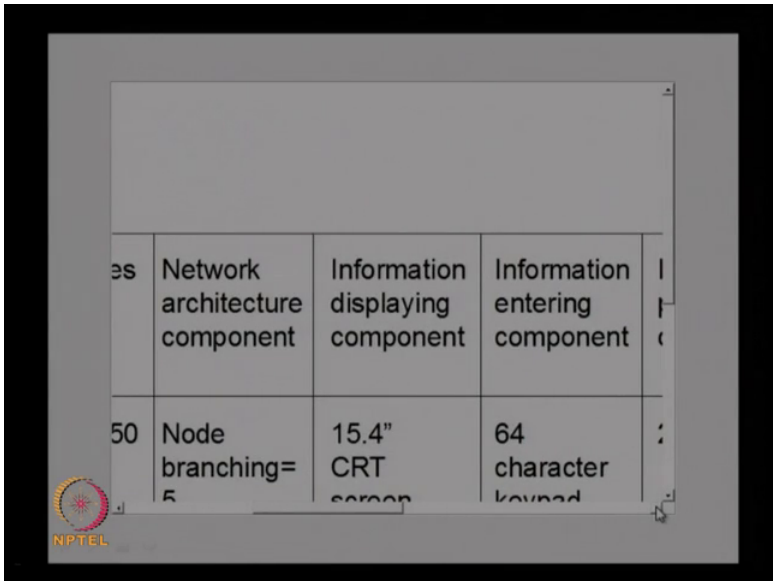

Then number of nodes network architecture components information display information entering component.

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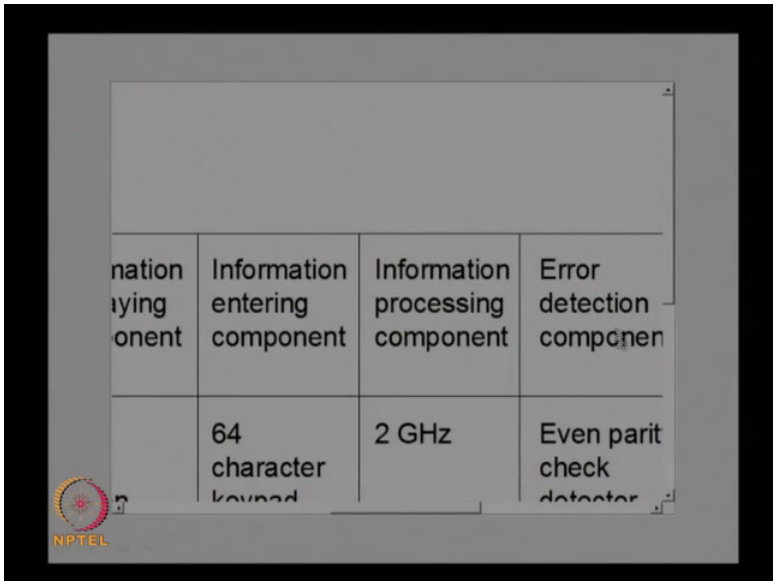


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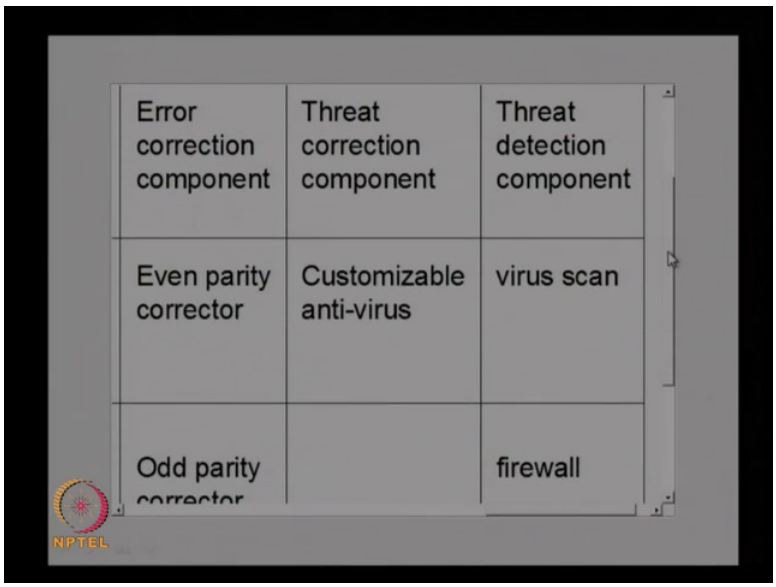


Then information processing component and error detection component; of course, we have the error correction component threat correction component and threat detection component also and we have different options for are these components you can see here can have a firewalls or virus scan device methods or antivirus options parity character

parity checking then we have the options for processing component where 2 gigahertz or 1.66.

Then the keypad options the display screen options nodes options, then we have the processing component option whether 5 gigahertz or 10 gigahertz and what kind of server to be used for information exchange.

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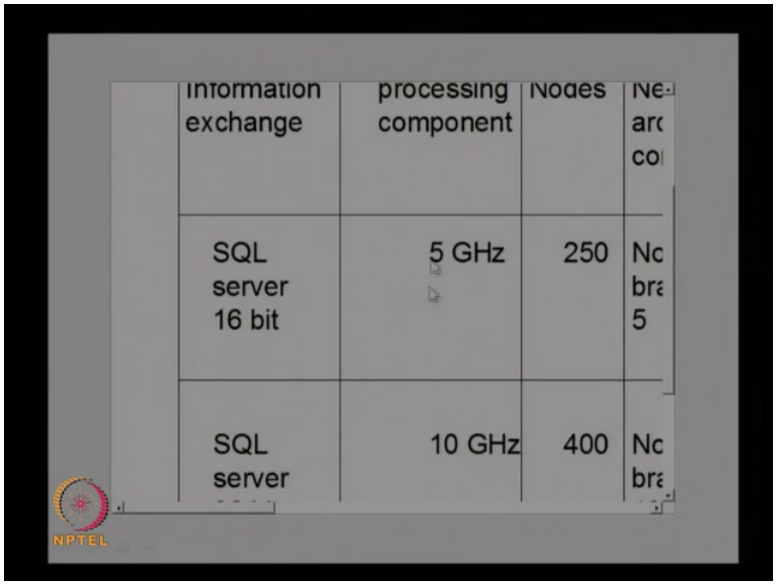


So, these are all come from the morphological box and depending on the requirement.

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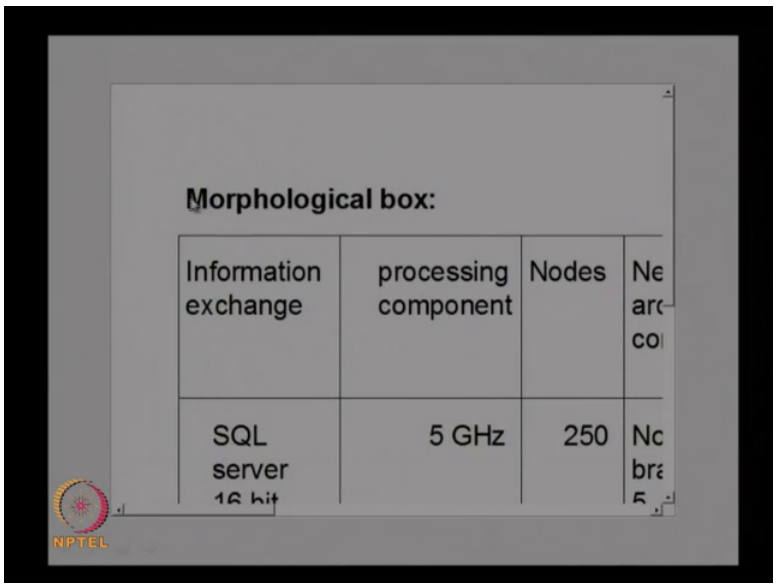

We can choose one of this and then developed the physical architecture. So, once we have the physical architecture, then we go ahead with the same method as discussed in the previous cases and go ahead to complete the physical system development.

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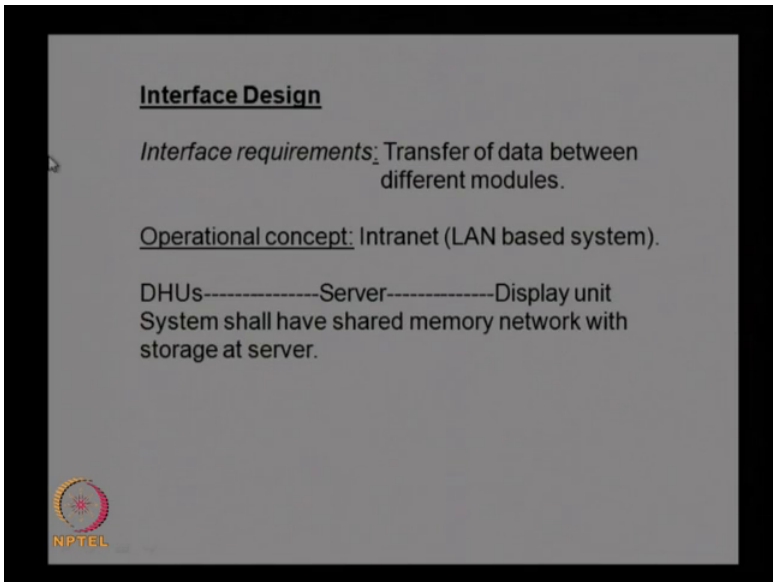


So, one important point is the interface design. So, as we discussed in previous cases also interfaces are one important point or failure point which we need to be designed with the full attention. So, that there will not be any fader in the interface.

So, we can actually have different operation concept for the interface. So, if you take this interface recommend if transfer of data between different modules we can have different options. So, we can have an internet as a operation concept and then identify the architecture for that particular interface.

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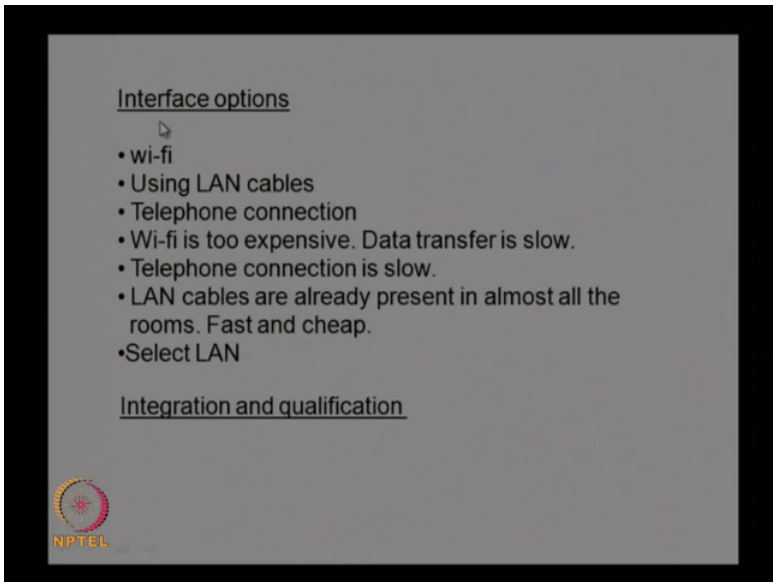


So, we can have different options like a Wi-Fi or LAN cables or telephone connection then based on the your all assessment you can actually decide what which one to be chosen. So, based on the pros and cons of different options we can choose the desired interface and then the next one is the integration qualification of the interface. So, again when we have this selecting one of the interfaces there will be many interfaces to be chosen. So, we choose all the interfaces all the components and then have the system integration and then qualifying the system.

So, once we have this identified or this interfaces components then we go for selecting the components and then integrating them and then as per the standard set for the qualification and inspection we will complete the system design process. So, that is how the particular system design process start from initial concept to the final system integration and testing qualification as well as acceptance. So, this completes the examples or diverge discussing for the last few classes basically the objective of this examples where to tell you how to use this principles in the real scenarios. So, whatever we learnt in the last twenty lectures can be directly implemented in any practical system design and we can see that when we provide a when we use a systematic way of system design we can get real benefits and it is very easy to make modifications or go back and then entry design the system at a later stage apart from the system design principles already we. So, there are few additional topics need to be covered as part of the system engineering and design course.

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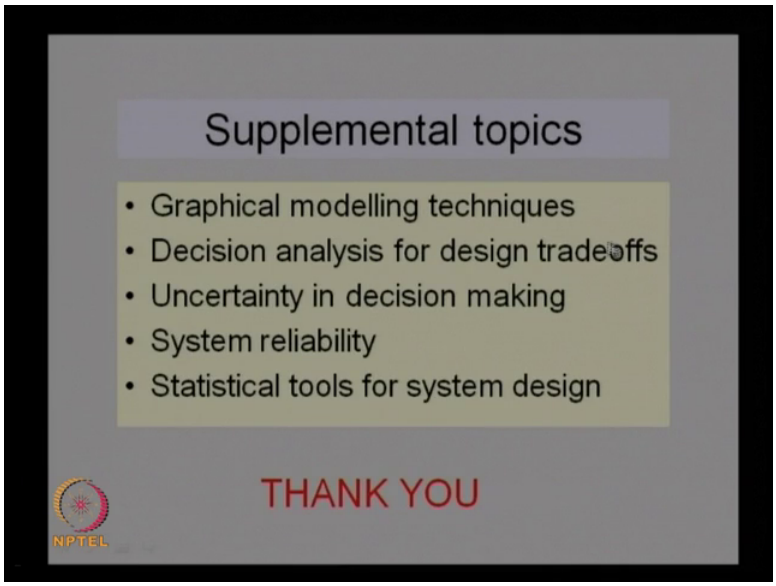


We have many graphical modeling techniques to be employed for system design and there are decision analysis for a design trade off. So, we need to make many decisions most of the times under uncertainty. So, how do we actually make decisions based on this and then how do we do the system reliability analysis and how do we identify methods for improving the system reliability and then some statistical tools for system design.

So, we will discuss about this topics in the next few classes and till we meet, goodbye to all of you.