COS221

Group Assignment 4

Members	Student Numbers
JH Kwak	u18279092
J Antalis	u19141859
LM Burgess	u18015001

Contents

DataCenter Table

Datacenter															
Datacenter								Room				Warehouse			
MTXid	Name	Location	Address	PlantSpecialists	EnergyConsumption	NumberOfServers	RackCount	RoomId	Capacity	RoomType	RoomName	WarehouseNo	Capacity	WarehouseName	WarehouseStatus

- Columns in Green are suggested groupings for nested attributes.
- Columns in Red are identified candidate keys for the relation.

Task 1 -Functional Dependencies

	Determining Attribute	Determines	Functional dependency 1	Functional dependency 2	Functional dependency 3	Functional dependency 4
1	MTXid	->	Name	Address	WareHouseNo	RoomID
2	RoomID	->	Room - Capacity	RoomType	RoomName	
3	WareHouseNo	->	Warehouse - Capacity	WarehouseName	WarehouseStatus	
4	NumberOfServers	->	RackCount	EnergyConsumption		
5	Address	->	Location			
6	Room - Capacity	->	RackCount			
7	WareHouse - Capacity	->	Room - Capacity			
8	Room - Capacity	->	NumberOfServers			
9	MTXid, RoomID, WarehouseNo	->	PlantSpecialist			

Task 2- Candidate Keys

Candidate Key	Rationale
{MTXid}	Determines the datacenter major
{RoomID}	Determines the room in the datacenter
{WareHouseNo}	Determines a warehouse making up part of a datacenter
{Mtxid, RoomID, WareHouseNo}	Together they make up a unique datacenter room

Task 2- Suggested Foreign Keys (to existing and potential relations)

Foreign Key	Rationale
PlantSpecialists	Links to project table with project ID or has a singular emplID

Energy Equipment Table

EnergyEquipment														
EnergyEquipment										Rectifier				
EquipmentID	EqName	Rating	Utilization	ServiceStatus	CommsProtocol	Location	MTXid	Model	SerialNumber	RectID	RectCapacity	RectUtilization	ActiveAlarms	ServiceDate

Continued:

UPS-Service				Generator					Transformers			
UPSNo	UPSCapacity	UPSUtilization	UPSStatus	GenID	GenCapacity	GenUtilization	ActiveAlarms	ServiceDate	TransformerID	TransformerID	TransformerRating	TransformerUtilzation

- Columns in green are suggested nested attributes.
- Columns in gold are suggested candidate keys.

Task 1 Functional Dependencies

	Determining Attribute	Determines	Functional dependency 1	Functional dependency 2	Functional dependency 3	Functional dependency 4	Functional dependency 5	Functional dependency 6	Functional dependency 7	Functional dependency 8
1	EquipmentID	->	EqName	Rating	Utilization	ServiceStatus	CommsProtocol	Location	Model	SerialNumber
2	GenID	->	GenCapacity	GenUtilization	ActiveAlarms	ServiceDate				
3	RectID	->	RectCapacity	RectUtilization	ActiveAlarms	ServiceDate				
4	UPSNo	->	UPSCapacity	UPSUtilization	UPSStatus					
5	TransformerID	->	TransformerID	TransformerRating	TransformerUtilzation					
6	Model	->	Utilization	Rating						

Task 2- Candidate Keys

Candidate Key	Rationale
{EquipmentID}	Identifies the equipment
{RectID}	Identifies the rectifier
{UPSNO}	Identifies the UPS device
{GenID}	Identifies the generator
{TransformerID}	Identifies the transformer

Task 2- Suggested Foreign Keys (to existing and potential relations)

Foreign Key	Rationale
MTXid (given)	Given in the relation and is identified as a foreign key

Server Table

Server											
ServerID	ServerName	RackID	RackLabel	Model	SerialNumber	ProcessorDetails	Utilization	Vendor	VMNames	VMCount	ResponsibleStaff

- Columns in gold are suggested candidate keys.

Task 1 Functional Dependencies

	Determining Attribute	Determines	Functional dependency 1	Functional dependency 2	Functional dependency 3	Functional dependency 4
1	{ServerID}	->	ServerName	VMNames	VMCount	RackID
2	{Model}	->	ProcessorDetails	Vendor	SerialNumber	
3	{RackID, SeverID}	->	ResponsibleStaff			
4	{RackID}	->	RackLabel			

Task 2- Candidate Keys

Candidate Key	Rationale
{ServerID}	Identifies the server
{RackID}	Identifies the rack which may hold 1 to many servers
{ServerID,RackID}	Identifies ResponsibleStaff

Task 2- Suggested Foreign Keys (to existing and potential relations)

Foreign Key	Rationale
MTXid	What center does the server belong to
RoomID, WareHouseNo	Where in the center the rack is contained
VMCodes	Relate to a VM table instead of a composite attribute VMNames
ResponsibleStaff	StaffID or links instead to the ProjectID table to all responsible staff or another new relation

Staff Table

Staff											
EmplID	Name	Address	PhoneNumber	Department	EmergencyContacts	ProjectID	ProjectName	HoursInDataCenter	Supervisor	Age	HealthStatus

- Columns in gold are suggested candidate keys.

Task 1 Functional Dependencies

	Determining Attribute	Determines	Functional dependency 1	Functional dependency 2	Functional dependency 3	Functional dependency 4	Functional dependency 5	Functional dependency 6	Functional dependency 7	Functional dependency 8
1	EMPLID	->	Name	Address	PhoneNumber	EmergencyContact	ProjectID	HoursInDataCenter	Age	HealthStatus
2	ProjectID	->	Supervisor	ProjectName						
3	Department	->	Supervisor							

Task 2- Candidate Keys

Candidate Key	Rationale
{EmpID}	Identifies the employee
{ProjectID}	Identifies the ProjectName and Department

Task 2- Suggested Foreign Keys (to existing and potential relations)

Foreign Key	Rationale
ProjectID	Relate to a more detailed project relation
EmergencyContactID (or use EmergencyContact)	Relate to a table with the emergency contacts details
MTXid, RoomID, WareHouseNo	Relate to where they work (this may also be linked relationally through projectID perhaps)

Task 3 -Suggested extra relations

ServerUtilization	DCIM’s have a goal of monitoring the usage of the system to identify efficiencies and redundancies within the system.

Attributes

ServerID	RackID	PeakEnergyCosnumption	PeakEnergyDuration	IDLE_Consumption	IDLE_Duration	DiskUtilization_Average	Peak_DiskUtil	Lowest_DIskUtil

Recovery Systems	DCIM aim to identify points of critical risk and redundancy within a datacenter such that no data is lost because of some sort of incident. Server can be chained MainServer – BackUpServer – MainServer depending on the number of backups and levels of redundancies desired with a certain raid level.

Attributes

MainServer (ServerID)	BackUpServer (ServerID)	LastBackUp	RaidLevel

AirFlow_Logistics	DCIM companies are hiring mechanical engineers to design the airflow of the racks/ server blocks in the center rooms to be more temperature efficient and increase server performance under intense load

Attributes

RoomID	AirflowEngineer (EMPLid)	HighestTemp	High_duration	LowestTemp	Low_duration	dailyPowerConsumption

CounterMeasureSystems	The monitoring systems of a datacenter are important in determining any possible flaws in protecting the datacenter physically and electronically

Attributes

RoomID	CoolingType	UPSID	AirControlEngineer	TemperatureControlSystemID	SiteMonitorID (staff member)	AI_MonitoringSystemID	SecuritySoftwareID

SoftwareUtilities		Software utilities which are applied to certain servers, racks, rooms, or warehouses this may be based on the DCIM contract of the client (if independently contracted)
Attributes		
ServerID	SofwareID	SoftwareName

Clients				DCIM’s may be independently contracted by a company to solve all their DCIM requirements. This may be extended with a table for linking the relevant servers, rooms, warehouses, software etc. to the client
Attributes				
ClientID	ClientName	ContactDetails	LengthOfContract	ResponsibleEmployee

Possible tables inferred from given tables:

- Project table for projects
- Datacenter locations table
- Virtual Machines table
- Emergency Contact details table

Task 4

The clients table is chosen to be added to the schema:

ClientID
License
Name
Contract_Details
Name
Contract_Start
Contract_End
Contract_Length
Servers
ProjectID
Responsible_Employee

Table Normal Forms

Datacenter, Server, Staff and Client are in no normal form due to the multivalued attributes PlantSpecialists, VMNames, Names, servers respectively.

Server, and EnergyEquipment also contain nested relations (multivalued in nature) being for Server: Room and for EnergyEquipment having: Rectifier and Generator.

Thus, EnergyEquipment is also in no normal form.

BCNF

None of the tables fulfill the requirements before normalization for Boyce-Codd normal form (BCNF). BCNF is required for a table to be in at least normal form two to allow normalization to either BCNF or Normal form three.

BCNF helps prevent update anomalies and tables with redundancies from being formed. The attribute is required to be a prime attribute which is an attribute fully functionally dependent on the primary key.

Anomalies

Insert Anomaly

Insert anomalies occur when data cannot be added to a relation due to the primary key being given a value of null. This may be due to a relation not being focused on a single entity.

Example 1 - Datacenter

A new warehouse is built but has not been assigned to a datacenter. Nor any of its room.

Example 2 - Datacenter

A new room is cleared out in a datacenter and becomes unused.

Example 3 - Datacenter

A new datacenter is designated but no warehouses nor rooms have been designated yet.

Example 4 – Energy Equipment

A new generator is purchased but cannot be added until it is associated with a UPS, Transformer, Rectifier and EquipmentID.

Example 5 – Energy Equipment

Similarly, a transformer cannot be added alone

Example 6 – Energy Equipment

A UPS cannot be added alone.

Example 7 – Energy Equipment

A Rectifier cannot be added alone.

Example 8 – Server

A new rack is purchased or made but cannot be added to the system until associated with a server.

Example 9 – Staff

A new project can only be added after a staff member is assigned to it.

Modification Anomaly

Modification anomalies occur when an attribute in a relation is to be updated but not all the desired tuples holding the attribute are updated. This leads to a contradiction in information between an old and new value. This may be caused by data being stored redundantly and the update process (query/transaction) being performed incorrectly to change the attribute's value. Possibly if more than one set of candidate keys may be used to query the data and the data to be updated is redundantly stored in the relation.

Example 1 – Datacenter

Datacenters belong to a certain location. If the location were to change all the associated MTXid with room and warehouse combinations would be required to be changed accordingly.

Example 2 – Datacenter

The status on a warehouse changes. All associated datacenters are required to be updated. A query involving the MTXid is used.

Example 3 – Energy Equipment

The rating of the transformer is desired to be updated. All energy equipment associated must be updated.

Example 4 – Energy Equipment

A specific UPS has its status changed. All the UPS's must be updated.

Example 5 – Server

A certain rack model changes. All racks using the model must be changed.

Example 6 – Staff

A project name changes, all pertaining records must be updated.

Delete Anomaly

Deletion anomalies occur when information is lost in a deletion. Certain information may be contained as attributes in a tuple. This information is desired to exist in the schema but is lost when no tuple holds the information. This information then ceases to exist when the tuple is deleted. This is again due to a relation not being focused on a singular entity.

Example 1 – Datacenter

If a single data center holds unique information with regards to a Room and Warehouse, when the datacenter is deleted, this information is lost in the process.

Example 2 – Energy Equipment

When an equipment ID is to be deleted, unique rectifier, UPS and transformer info is lost in the deletion if only contained in a single record.

Example 3 – Server

Rack and VM information are lost when the Server is to be deleted if held in a singular record.

Example 4 – Staff

Project information is lost when the last staff member from the project is deleted.

Some simplifications

Datacenter has the composite attribute PlantSpecialists which is simplified into a SpecialistID and Name field. This field can be repeated N times depending on the workforce required.

Staff has the names field defined as a first, middle and last name; that is then treated as a nested relation staff names

Task 5

Datacenter

First normal form:

Datacenter has an identified nested relation ROOM, and composite attribute PlantSpecialists. It is decomposed into:

Datacenter

Name	Location	Address	EnergyConsumption	NumberOfServers	RackCount	MTXid	WareHouseNo	Capacity	WareHouseName	WareHouseStatus

Room

MTXid	RoomID	Capacity	RoomType	RoomName	RoomStatus

PlantSpecialists

MTXid	SpecialistID	SpecialistName

Second normal form

For datacenter, the candidate key {MTXid,WareHouseNo} will be defined as the primary key for the relation as a datacenter may be spread across multiple warehouses. Thus the attributes regarding Warehouse are not fully functionally dependent on the key and the details relating to the datacenter similarly. The relation is decomposed further as followed:

Datacenter-Spread

MTXid	WareHouseNo	Location	Address

WareHouse

WareHouseNo	Capacity	WareHouseName	WarehouseStatus

Datacenter

MTXid	Name	EnergyConsumption	NumberOfServers	RackCount

Room_sub

MTXid	RoomID

Room

RoomID	Capacity	RoomName	RoomType	RoomStatus

PlantSpecialists_sub

MTXid	SpecialistID

PlantSpecialists

SpecialistID	SpecialistName

Third normal form

Datacenter has the rack count and energy consumption transitively dependent on the NumberOfServers. Location is transitively dependent on the address.

Datacenter-Spread

MTXid	WareHouseNo	Address

Datacenter Locations

Address	Location

Datacenter

MTXid	Name	NumberOfServers

Datacenter Consumption info

NumberOfServers	RackCount	EnergyConsumption

BCNF

All the above relations follow BCNF.

Energy Equipment

First normal form

EnergyEquipment has been identified to contain the nested relations: rectifier and Generator. It is decomposed into:

EnergyEquipment

EquipmentID	EqName	Rating	CommsProtocol	ServiceStatus	Location	MTXid	Model	SerialNumber	UPSNO	UPSCapacity	UPSUtilization	UPS_Status
TransformerID				TransformerRating				TransformerUtilization				

Rectifier

MTXid	RectID	RectCapacity	RectUtilization	ActiveAlarms	ServiceDate

Generator

MTXid	GenID	GenCapacity	GenUtilization	ActiveAlarms	ServiceDate

Second normal form

EnergyEquipment: EquipmentID with MTXid is the primary key as the code would be desired to be unique to monitor all equipment uniquely and ensure no equipment go missing and requires to exist at a datacenter. Model functionally determines the rating among other attributes. The tables are decomposed as followed:

EnergyEquipment

EquipmentID	MTXid	UPSNO	TransformerID

EquipmentInfo

EquipmentID	EqName	Location	Model	CommsProtocol	Rating	Utilization	SerialNumber	ServiceStatus

UPS

UPSNO	UPSCapacity	UPSUtilization	UPS_Status

Transformers

TransformerID	TransformerRating	TransformerUtilization

Rect sub

MTXid	RectID

Rectifier

RectID	RectCapacity	RectUtilization	ActiveAlarms	ServiceDate

Generator sub

MTXid	GenID

Generator

GenID	GenCapacity	GenUtilization	ActiveAlarms	ServiceDate

Third normal form

Model functionally determines some characteristics of the equipment.

EquipmentInfo

EquipmentID	EqName	Location	Model	CommsProtocol

EqModel info

Model	Rating	Utilization	SerialNumber	ServiceStatus

BCNF

Defining the superkey as {EquipmentID, MTXid}, UPSno and TransformerID are decomposed further due to being dependent on EquipmentID only:

EnergyEquipment

EquipmentID	MTXid

UPS_Equipment

EquipmentID	UPSNO

Transformer_Equipment

EquipmentID	TransformerID

Server

First normal form

Server has been identified to contain a composite attribute VM_Names, it is decomposed as followed:

Server

ServerID	RackID	ServerName	RackLabel	Model	SerialNumber	ResponsibleStaff	Utilization	Vendor	VMCount	ProcessorDetails

VM Names

ServerID	VM Name

Second normal form

Server is decomposed as followed based on a candidate key of ServerID and RackID:

Server

ServerID	RackID	ResponsibleStaff

Server info

ServerID	ServerName	VMCount

Rack info

RackID	RackLabel	Model	SerialNumber	Utilization	Vendor	ProcessorDetails

Third normal form

Info about the rack is transitively dependent on the model of the rack model.

Rack_info

RackID	RackLabel	Model	Utilization

Rack_models

Model	SerialNumber	Vendor	ProcessorDetails

BCNF

The tables all conform to BCNF.

Staff

First normal form

Staff has been identified to contain the composite attributes EmergencyContacts and Names it is decomposed as followed:

Staff

Name	Address	EmplID	PhoneNumber	Department	ProjectID	ProjectName	HoursInDataCenter	Supervisor	Age	HealthStatus

Emergency Contacts

EmplID	EM fname	EM Sname	EM phone

Staff names

EmplID	fName	mName	sName

Second normal form

The candidate key of {ProjectID, EmplID} is used:

Staff_Projects

EmplID	ProjectID

Employee info

Name	Address	EmplID	PhoneNumber	Department	HoursInDataCenter	Supervisor	Age	HealthStatus

Project info

ProjectID	ProjectName

Third normal form

Employee info

Name	Address	EmplID	PhoneNumber	Department	HoursInDataCenter	Age	HealthStatus

Department Supervisor

Supervisor	Department

BCNF

The tables all conform to BCNF.

Client

First normal form

The added custom table has the complex attributes ContactDetails and servers decomposed.

Client

Client ID	Name	ContractName	Contract_Start	Contract_End	Contract_Length	ProjectID	Responsible_Employee	License

Client ContactInfo

Client ID	ContactDetails

Client Servers

Client ID	Servers

Second normal form

Client

Client ID	Name	ProjectID	Responsible_Employee	License

Contracts

ProjectID	ContractName	Contract_Start	Contract_End	Contract_Length

Third normal form

Conforms.

BCNF

Conforms.

Final Tables

Datacenter

Datacenter-Spread

MTXid	WareHouseNo	Address

Datacenter Locations

Address	Location

WareHouse

WareHouseNo	Capacity	WareHouseName	WarehouseStatus

Datacenter

MTXid	Name	NumberOfServers

Datacenter Consumption info

NumberOfServers	RackCount	EnergyConsumption

Room sub

MTXid	RoomID

Room

RoomID	Capacity	RoomName	RoomType	RoomStatus

PlantSpecialists sub

MTXid	SpecialistID

PlantSpecialists

SpecialistID	SpecialistName

Energy Equipment

EnergyEquipment

EquipmentID	MTXid

UPS_Equipment

EquipmentID	UPSNO

Transformer_Equipment

EquipmentID	TransformerID

EquipmentInfo

EquipmentID	EqName	Location	Model	CommsProtocol

EqModel_info

Model	Rating	Utilization	SerialNumber	ServiceStatus

UPS

UPSNO	UPSCapacity	UPSUtilization	UPS_Status

Transformers

TransformerID	TransformerRating	TransformerUtilization

Rect_sub

EquipmentID	RectID

Rectifier

RectID	RectCapacity	RectUtilization	ActiveAlarms	ServiceDate

Generator_sub

EquipmentID	GenID

Generator

GenID	GenCapacity	GenUtilization	ActiveAlarms	ServiceDate

Server

Server

ServerID	RackID	ResponsibleStaff

Server info

ServerID	ServerName	VMCount

VM Names

ServerID	VM Name

Rack info

RackID	RackLabel	Model	Utilization

Rack models

Model	SerialNumber	Vendor	ProcessorDetails

Staff

Staff Projects

EmplID	ProjectID

Employee info

Name	Address	EmplID	PhoneNumber	Department	HoursInDataCenter	Age	HealthStatus

Department Supervisor

Supervisor	Department

Project info

ProjectID	ProjectName

Emergency Contacts

EmplID	EM fname	EM Sname	EM phone

Staff_names

EmplID	fName	mName	sName

Client

Client

Client_ID	Name	ProjectID	Responsible_Employee	License

Contracts

ProjectID	ContractName	Contract_Start	Contract_End	Contract_Length

Client_ContactInfo

Client_ID	ContactDetails

Client_Servers

Client_ID	Servers