Relational Database Design Final Project

Background :

For almost 15 years, the client, the Water Tower Condominium HOA association has managed its apartment/condo complex without the assistance of a property management firm. The Water Tower condominiums is a 60-story structure with roughly 500 individual apartments, including luxury studio, one-, two-, and three-bedroom condominiums. The building features its own parking area, indoor pool, gym, kids' playroom, park, and party hall.

Their board of directors underwent a change following a recent election. Following an assessment of their present file management system, the new board of directors determined that it was inadequate and unscalable for all their current and future demands. The HOA board of directors wants to record information about Condominiums, Homeowners, staff, service requests, HOA Collections, companies rendering services and expenses.

During the meeting with the board of directors, the entities , the relationship of the entities and identities for each of the entities was recorded. The nature of the relationship – mandatory or optional participation and cardinalities were clarified.

Building an ER model:

The **entities** identified are the following:

➢ Condos – This entity records the attributes of all the condos of the building.
➢ Homeowners - Records the attributes of only the homeowners and not all the residents/occupants of the condo.
➢ Parking – Records of the attributes of the parking space and its owners.
➢ Staff - Records the attributes of the personnel working for the condo. The personnel are hired via contracting from a staffing agency and hence the payroll details have been omitted.
➢ Expenses – Records the expenses incurred by the HOA for the maintenance of the building, like pool maintenance, water, electricity etc. This includes the expenses for staff.
➢ Service Company – records the attributes of the businesses that provide services to the condominium like staffing, electricity, lawn maintenance, snow removal etc.
➢ Service Request – Records the details of the service requests placed by the homeowners.
➢ HOA Collection – Records the monthly HOA payments made by the homeowners.
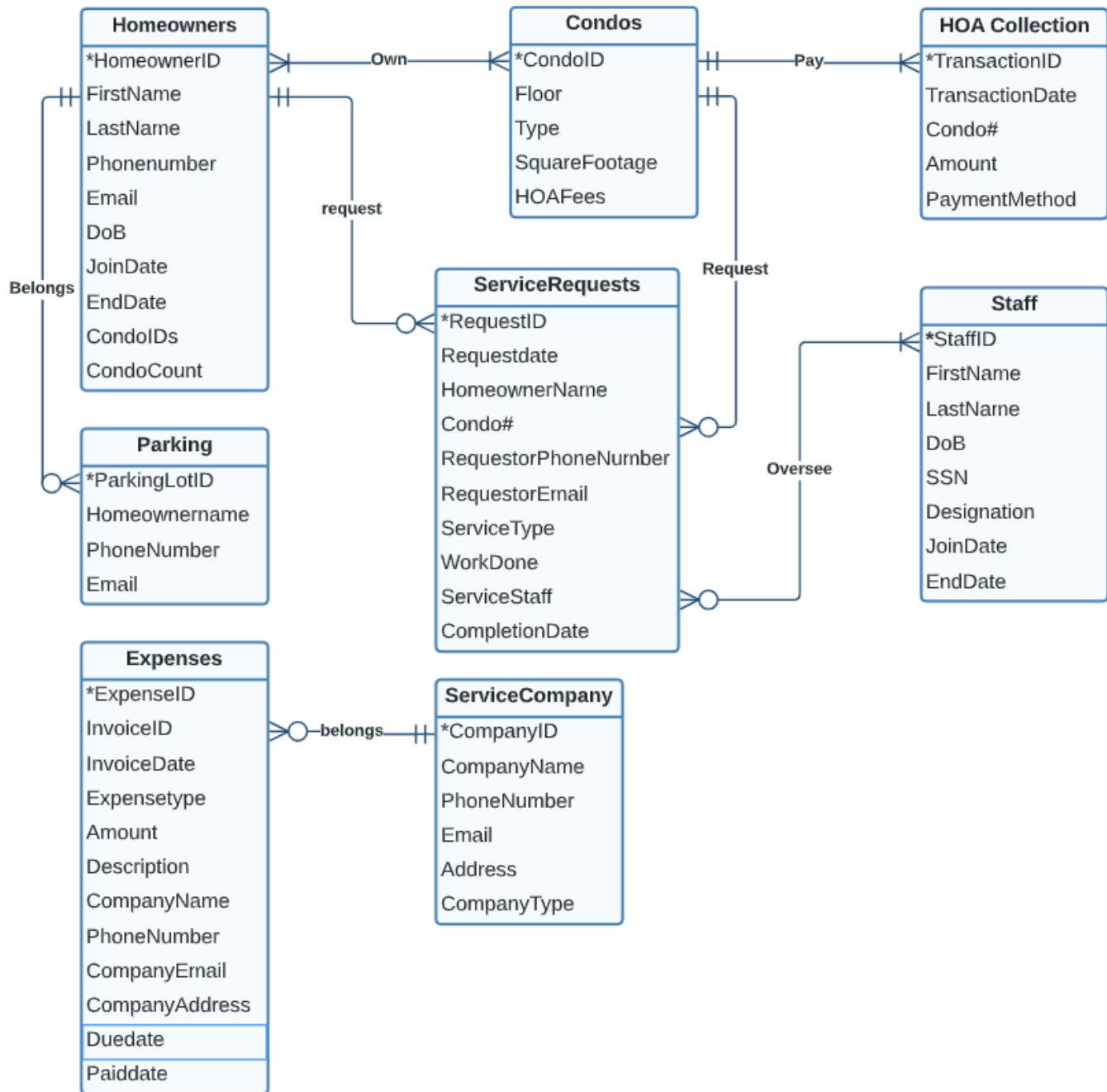
The relationships:

➢ A Condo **must** have **one or more** homeowners. A Homeowner **must** have **one or more** condos.
➢ A homeowner **may** have **one or more** parking lots. A parking lot **must** belong to **one and only one** homeowner.
➢ A Service request **must** belong to **one and only one** requestor/homeowner. A homeowner **may** have **one or many** service requests .
➢ A Service request **must** be assigned to **one or many** staff . A staff **may** oversee **one or more** service requests.
➢ A service request **must** belong to **one and only one** condo. A condo **can** issue **one or more** service requests.

- An HOA expense invoice **must** be billed by **one and only one** service company. A company **may** have **one or more** expense invoices.
- A HOA payment **must** be paid by **one and only one** condo. A condo **must** make **1 or many** HOA payments.

Entities, Attributes and Identifiers:

Entities	Attributes	Identifiers
Condos	CondoID, Floor#, Squarefootage, Type, HOA fees	CondoID
Homeowners	HomeownersID, Firstname, Lastname, Phone number, DOB, Email, Joindate, Enddate, CondoIDs, CondoCount	HomeOwnersID
Parking	ParkinglotID, HomeOwnerName, Phonenumber, Email	ParkinglotID
Staff	StaffID, Firstname, Lastname, DOB, SSN, Designation, Joindate, Enddate	StaffID
Expenses	ExpenseId, Invoice#, expensetype, Amount, Invoicedate, companyname, CompanyPhonenumber, Companyemail, CompanyAddress, Duedate,Paiddate	ExpenseID
ServiceCompany	CompanyID, Companyname, Phonenumber, email, Address, CompanyType	CompanyID
HOA Collection	TransactionID, Transactiondate, Condo#, Amount, PaymentMethod	TransactionId
ServiceRequests	RequestID, RequestDate, Homeownername, Condo#,Phonenumber,Email, Servicetype, Description, Servicestaff, Priority, completiondate	RequestID

Create the Entity Relationship Diagram:

Homeowners
*HomeownerID
FirstName
LastName
Phonenumber
Email
DoB
JoinDate
EndDate
CondoIDs
CondoCount

Condos
*CondoID
Floor
Type
SquareFootage
HOAFees

HOA Collection
*TransactionID
TransactionDate
Condo#
Amount
PaymentMethod

— Own —
— Pay —
request
Request
Belongs

ServiceRequests
*RequestID
Requestdate
HomeownerName
Condo#
RequestorPhoneNumber
RequestorEmail
ServiceType
WorkDone
ServiceStaff
CompletionDate

Staff
*StaffID
FirstName
LastName
DoB
SSN
Designation
JoinDate
EndDate

Oversee

Parking
*ParkingLotID
Homeownername
PhoneNumber
Email

Expenses
*ExpenseID
InvoiceID
InvoiceDate
Expensetype
Amount
Description
CompanyName
PhoneNumber
CompanyEmail
CompanyAddress
Duedate
Paiddate

— belongs —

ServiceCompany
*CompanyID
CompanyName
PhoneNumber
Email
Address
CompanyType

Convert the ERD to a relational model :

Condos (<u>CondoID</u>, Floor#, Squarefootage, Type, HOA fees)
Homeowners (<u>HomeownersID</u>, Firstname, Lastname, Phone number, DOB, Email, Joindate, Enddate, CondoCount)
Condos_Homeowners (<u>CondoID(fk)</u>, <u>HomeownersID(fk)</u>)
Parking (<u>ParkinglotID</u>, HomeOwnerName, Phonenumber, Email, HomeownersID(fk))
Staff (<u>StaffID</u>, Firstname, Lastname, DOB, SSN, Designation, Joindate, Enddate)
Expenses (<u>ExpenseId</u>, Invoice#, expensetype, Amount, Invoicedate, companyname, CompanyPhonenumber, Companyemail, CompanyAddress, Duedate, Paiddate, CompanyID(fk))
Servicecompany (<u>CompanyID</u>, Companyname, Phonenumber, email, Address, CompanyType)
HOACollection (<u>TransactionID</u>, Transactiondate, CondoID(fk) , Amount, PaymentMethod)
ServiceRequests (<u>RequestID</u>, RequestDate, Homeownername, Phonenumber, Email, Servicetype, Description, Priority, completiondate , HomeownerID(fk), CondoID(fk))
ServiceRequests_Staff (<u>RequestID(fk)</u> , <u>StaffID(fk)</u>)

Functional Dependencies:

The following are the functional dependencies of the relations.

- **Condos (** <u>CondoID</u>, Floor#, Squarefootage, Type, HOA fees)
  - **FD1 :** CondoID → Floor#, Squarefootage, Type, HOA fees
  - **FD2 :** Squarefootage, Type → HOA fees

- **Homeowners (** <u>HomeownersID</u>, Firstname, Lastname, Phone number, DOB, Email, Joindate, Enddate, CondoCount **)**
  - **FD1 :** HomeownersID → Firstname, Lastname, Phone number, DOB, Email, Joindate, Enddate, CondoCount

- **Parking (** <u>ParkinglotID</u>, HomeOwnerName, Phonenumber, Email, HomeownersID(fk) **)**
  - **FD1 :** <u>ParkinglotID</u> → OwnerName, Phonenumber, Email, HomeownersID
  - **FD2 :** HomeownersID → OwnerName, Phonenumber, Email

- **Condos_Homeowners (** <u>CondoID(fk)</u>, <u>HomeownersID(fk)</u> **)**
  - **There is no non primary key attribute.**

- **Staff (** <u>StaffID</u>, Firstname, Lastname, DOB, SSN, Designation, Joindate, Enddate **)**
  - **FD1 :** <u>StaffID</u> → Firstname, Lastname, DOB, SSN, Designation, Joindate, Enddate

- **Expenses (** <u>ExpenseId</u>, Invoice#, expensetype, Amount, Invoicedate, companyname, CompanyPhonenumber, Companyemail, CompanyAddress, CompanyID(fk),Paiddate , Duedate**)**
  - **FD1 :** ExpenseId → Invoice#, expensetype, Amount, Invoicedate, companyname, CompanyPhonenumber, Companyemail, CompanyAddress, CompanyID
  - **FD2 :** Invoice# → Invoicedate, Amount, CompanyID, Duedate
  - **FD3 :** CompanyID → companyname, CompanyPhonenumber, Companyemail, CompanyAddress

- **Servicecompany** (<u>CompanyID</u>, Companyname, Phonenumber, email, Address, CompanyType)
  - **FD1 : Servicecompany** → <u>CompanyID</u>, Companyname, Phonenumber, email, Address, CompanyType

- **HOACollection (**<u>TransactionID</u>, Transactiondate, Amount, PaymentMethod, CondoID(fk)**)**
  - **FD1 :** TransactionID → Transactiondate, Amount, PaymentMethod, CondoID

- **ServiceRequests (** <u>RequestID</u>, RequestDate, Homeownername, HomeownerID(fk), CondoID(fk),Phonenumber, Email, Servicetype, Description, Priority, completiondate **)**
  - **FD1 :** RequestID → RequestDate, Homeownername, HomeownerID, CondoID,Phonenumber, Email, Servicetype, Description,Priority, completiondate
  - **FD2 :** HomeownerID → Homeownername, Phonenumber, Email

- **ServiceRequests_Staff (** RequestID(fk) **,** StaffID(fk) **)**
  - **There is no non primary key attribute.**

Normalize the Relational Model to 3NF :

- **Homeowners, ServiceRequests_Staff, HOACollection, Staff, Condo_Homeowners**, **Servicecompany** are in 3NF because they are in 1NF; they have no partial functional dependencies, so they are in 2NF; and they have no transitive functional dependencies, so they are in 3NF.

- **Condos (** <u>CondoID</u>, Floor#, Squarefootage, Type, HOA fees)
  - **FD1 :** CondoID → Floor#, Squarefootage, Type, HOA fees
  - **FD2 :** Squarefootage, Type → HOA fees

  Condos is in 1NF. There is no partial dependencies, hence it's in 2NF. But it exhibits transitive functional dependency, hence its not in 3NF. To normalize it to 3NF, we need to create a new relation.

  > **HOAFees_Info** (<u>CondoType</u> , <u>Squarefootage</u>, HOAfees)
  >
  >   - **FD1:** CondoType, Squarefootage → HOAfees

Modify the Condos relation by removing HOAfees

Condos (<u>CondoID</u>, Floor#, Squarefootage(fk), Type(fk))

- o **FD1:** CondoID → Floor#, Squarefootage, Type

Now we have two relations, and they are both in 3NF.

➢ **Parking (** <u>ParkinglotID</u>, HomeOwnerName, Phonenumber, Email, HomeownersID(fk) **)**
  - o **FD1 :** <u>ParkinglotID</u> → HomeOwnerName, Phonenumber, Email, HomeownersID
  - o **FD2 :** HomeownersID → HomeOwnerName, Phonenumber, Email

Parking is in 1NF. There are no partial dependencies, hence it's in 2NF. But it exhibits transitive functional dependency, hence it's not in 3NF. To normalize it to 3NF, we don't need to create a new relation as homeowners already has the information.

Modify the parking relation by removing HomeOwnerName, PhoneNumber & Email.

Parking (<u>ParkinglotID</u>, HomeownersID(fk))

- o **FD1:** ParkinglotID → HomeownersID

Now parking is in 3NF.

➢ **Expenses (** <u>ExpenseId</u>, Invoice#, expensetype, Amount, Invoicedate, companyname, CompanyPhonenumber, Companyemail, CompanyAddress, CompanyID(fk), Paiddate ,Duedate**)**
  - o **FD1 :** ExpenseId → Invoice#, expensetype, Amount, Invoicedate, companyname, CompanyPhonenumber, Companyemail, CompanyAddress, CompanyID
  - o **FD2 :** Invoice# → Invoicedate, Amount, CompanyID, Duedate
  - o **FD3 :** CompanyID → companyname, CompanyPhonenumber, Companyemail, CompanyAddress

Expenses are in 1 NF, 2NF but not in 3NF as it exhibits transitive functional dependency.

To resolve this creating 1 new relations – ExpenseInvoice

ExpenseInvoice (<u>Invoice#</u>, <u>CompanyID(fk)</u>, Invoicedate, Amount, Duedate)
- o **FD1 :** Invoice#, CompanyID(fk) → Invoicedate, Amount, Duedate

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ExpenseInvoice is now in 3NF.

Removing companyname, CompanyPhonenumber, Companyemail, CompanyAddress, Invoicedate, Amount,Duedate from Expenses. To normalize it to 3NF, we don't need to create a new relation for the companyname, CompanyPhonenumber, Companyemail, CompanyAddress, as servicecompany already has the information.

> **Expenses (** ExpenseId, Invoice#(fk), expensetype, CompanyID(fk), Paiddate **)**
> - **FD1 :** ExpenseId → Invoice#, expensetype, CompanyID, Paiddate

Now Expenses is in 3NF.

➢ **ServiceRequests (** RequestID, RequestDate, Homeownername, HomeownerID(fk), CondoID(fk),Phonenumber, Email, Servicetype, Description, Priority, completiondate **)**
- **FD1 :** RequestID → RequestDate, Homeownername, HomeownerID, CondoID, Phonenumber, Email, Servicetype, Description,Priority, completiondate
- **FD2 :** HomeownerID → Homeownername, Phonenumber, Email

ServiceRequests is in 1NF and 2NF but not in 3NF. Removing Homeownername, Phonenumber, Email from ServiceRequests. We don't need to create a new relation as homeowners already has the information.

> **ServiceRequests (** RequestID, RequestDate, HomeownerID(fk), CondoID(fk), Servicetype, Description, Priority, completiondate **)**
> - **FD1 :** RequestID → RequestDate, HomeownerID, CondoID, Servicetype, Description, Priority, completiondate

ServiceRequests is now in 3NF.

Finalized relational model in 3NF for further implementation :

> **Homeowners (** HomeownersID, Firstname, Lastname, Phone number, DOB, Email, Joindate, Enddate, CondoCount **)**
> - **FD1 :** HomeownersID → Firstname, Lastname, Phone number, DOB, Email, Joindate, Enddate, CondoCount

> **Condos** (CondoID, Floor#, Squarefootage(fk), Type(fk))
> - **FD1:** CondoID → Floor#, Squarefootage, Type

> **Condos_Homeowners (** CondoID(fk), HomeownersID(fk) **)**
> - **There is no non primary key attribute.**

> **HOAFees_Info** (CondoType , Squarefootage, HOAfees)
> - **FD1:** CondoType, Squarefootage → HOAfees

> **Parking** (ParkinglotID, HomeownersID(fk))
> - **FD1:** ParkinglotID → HomeownersID

> **Staff (** StaffID, Firstname, Lastname, DOB, SSN, Designation, Joindate, Enddate **)**
> - **FD1 :** StaffID → Firstname, Lastname, DOB, SSN, Designation, Joindate, Enddate

> **HOACollection (**TransactionID, Transactiondate, Amount, PaymentMethod, CondoID(fk)**)**
> - **FD1 :** TransactionID → Transactiondate, Amount, PaymentMethod, CondoID

Expenses (<u>ExpenseId</u>, Invoice#(fk), expensetype, CompanyID(fk), Paiddate **)**
- ○ **FD1 :** ExpenseId → Invoice#, expensetype, CompanyID, Paiddate

ExpenseInvoice (<u>Invoice#</u>, <u>CompanyID(fk)</u>, Invoicedate, Amount,Duedate **)**
- ○ **FD1 :** Invoice#, CompanyID(fk) → Invoicedate, Amount, Duedate

ServiceCompany (<u>CompanyID</u>, Companyname, Phonenumber, email, Address, CompanyType **)**
- ○ **FD1 :** CompanyID → companyname, Phonenumber, email, CompanyAddress, CompanyType

ServiceRequests (<u>RequestID</u>, RequestDate, HomeownerID(fk), CondoID(fk), Servicetype, Description, Priority, completiondate **)**
- ○ **FD1 :** RequestID → RequestDate, HomeownerID, CondoID, Servicetype, Description, Priority, completiondate

ServiceRequests_Staff (<u>RequestID(fk)</u> **,** <u>StaffID(fk)</u> **)**
- ○ **There is no non primary key attributes.**