Conceptual database design

Mark Christison

Nelson Marlborough Institute of Technology, New Zealand

Contents

[Executive Summary 4](#_Toc42636225)

[Introduction 5](#_Toc42636226)

[Business Rules 6](#_Toc42636227)

[Being There 6](#_Toc42636228)

[Databoxes 6](#_Toc42636229)

[Drone 7](#_Toc42636230)

[Subscriptions 7](#_Toc42636231)

[Contracts 7](#_Toc42636232)

[Zones 8](#_Toc42636233)

[Employees 8](#_Toc42636234)

[Video Streams 8](#_Toc42636235)

[Maintenance 8](#_Toc42636236)

[Parts 8](#_Toc42636237)

[Assumptions made from the Scenario 9](#_Toc42636238)

[Chens Diagram Rational 10](#_Toc42636239)

[Chens Conceptual Model 12](#_Toc42636240)

[Chens Diagraming Legend 13](#_Toc42636241)

[Conceptual Model Documentation 19](#_Toc42636242)

[Documented Entities 19](#_Toc42636243)

[Document Relationships 24](#_Toc42636244)

[Document Attributes 27](#_Toc42636245)

[Normalization 39](#_Toc42636246)

[Standard Notation 39](#_Toc42636247)

[Unnormalized Form 40](#_Toc42636248)

[First Normal Form (1NF) 40](#_Toc42636249)

[Second Normal Form (2NF) 41](#_Toc42636250)

[Third Normal Form (3NF) 41](#_Toc42636251)

[Boyce-Codd Normal Form (BCNF) 42](#_Toc42636252)

[Fourth Normal Form 4NF 42](#_Toc42636253)

[Conceptual to Logical Mapping Rules 43](#_Toc42636254)

[Crows Foot ERD Legend 45](#_Toc42636255)

[Rational for ERD 47](#_Toc42636256)

[Logical ERD 48](#_Toc42636257)

[Data Dictionary 49](#_Toc42636258)

[Entities 49](#_Toc42636259)

[Attributes 51](#_Toc42636260)

[NaLER Analysis 78](#_Toc42636261)

[Attribute sentences 78](#_Toc42636262)

[Relationship sentences 85](#_Toc42636263)

[Conclusion 92](#_Toc42636264)

[References 93](#_Toc42636265)

# Executive Summary

Being there has a need for a database for their expanding business to allow the ease of transfer of collected data to their customers. The database that will be developed for their use needs to first be well understood from a conceptual standpoint. This document supplies a conceptual model and data dictionary that addresses that need. The conceptual model and data dictionary have been surmised from the problem description as provided by being there. The documentation of the database allows for the continued collaboration with being there, and amendments or adjustments will be included in future iterations of the database creation.

The problem has been simplified to a set of business rules. These describe the operation and specifics of all the relevant parts of the business. A list of assumptions has been made where there is ambiguity in the problem provided.

The conceptual model developed follows the Chen’s Entity Relationship modeling format. To aid the understanding of these models for the reader, a legend has been included to document the model.

A further break down of each of the entities, relationships and attributes concludes the documentation.

# Introduction

Conceptual database models were first introduced by Peter Chen in 1976. The conceptual model helps in the development of the database by simply laying out the entities and showing the connections between those entities as relationships, without going into specifics around the construction of that database. The conceptual model specifically does not include information regarding data types, size of schema, or limit the construction to a specific database language or framework.

The developed of the Entity Relationship Diagrams (ERD) allow for all stakeholders to have a greater understanding of the database that is being developed. This simpler model allows for collaboration from domain exerts, which in the case of being there, would be the being there employees, scientist customers of being there, and private agencies who are customers of being there.

The Chen’s ER model is not specific to a database language or framework. The model only provides the basic information about the system: the entities, the relationships between the entities and the entities attributes.

The Chens ER model provided uses the extended notation. While not part of the original model, it more closely models how a data base can work in a modern sense, using inheritance.

# Business Rules

The Following business rules have been extracted and interpreted from the provided Scenario. Assumptions have been made where there was ambiguity in the brief.

## Being There

* Provides video streaming and data sensing/collection services to government services, commercial entities and private individuals
* Operates worldwide by deploying devices internationally
* More than 50,000 databoxes currently deployed
* Planning on expanding business to provide remote roaming at a distance, meaning that databoxes may share zones

## Databoxes

* Are a mobile device called a “BT Databox”
* Has devices installed to provide data sensing and video streaming
* Communicates with satellites and cellular networks
* Can be accessed and managed through a computer application
* Can be moved into a subscribed zone
* Records data obtained every second which includes
  + Latitude
  + Longitude
  + Altitude
  + Temperature
  + Humidity
  + Ambient Light Strength
* Every 10 seconds the data on the databox is sent to a database for permanent record
* Databoxes can be linked to a contract by either a zone or directly by a contractor
* Can transmit a 3D live Stream
* Are maintained by the owner of the device with the databox connects to
* Can be configured and deployed to different geological conditions including
  + Jungle
  + Forest
  + Savannah
  + Ice and Snow (extreme cold)
  + Deserts
  + Urban

## Drone

* Are owned by one person.
* Connect to the databox and provide it with locomotion
* Drone owners ensure the correct operation of the bt databox
* Drone owner is compensated from Being There for data collection and video streams provided by the attached bt databox.
* Send the bt databox for servicing as required by being there to ensure the highest quality of data

## Subscriptions

* Subscriptions are sold to the public
* Subscribers pay a monthly fee to Being There to maintain their subscription
* Subscriptions can be discounted by up to 3%
* Subscriptions may be to databoxes or geographical zones
* The cost of subscriptions may be changed from time to time
* Subscriptions have 4 different tiers
  + Regular
    - May view video streams
  + Gold
    - All Regular subscription features
    - Can control the video stream
  + Platinum
    - All Gold subscription features
    - Maintain rights to collected data
  + Super Platinum
    - All Platinum subscription features
    - Maintain rights to video streams

## Contracts

* Contracts are signed by government organizations and commercial entities
* Contract requirements in terms of data and video streams determine where bt databoxes are located geographically
* Contracts cover geographical areas which can overlap with other contracted zones
* Contracts have allocated bt databoxes
* The amount of bt databoxes and the size of the zone are determined in the contract conditions
* Contractors maintain rights to data and video streams

## Zones

* Zones cover a geographical area
* Zones can be subscribed to by subscribers
* Zones can be covered by many contract

## Employees

* Being There employee’s maintenance staff, sales staff, administration executives and directors
* Maintenance staff can service BT databoxes and order parts for the work that carry out
* Sales staff can sell subscriptions and adjust discounts up to 3% on each sale
* Administration executives enter the details of contracts
* Directors set the prices of subscriptions

## Video Streams

* Are a 3d video stream that can be viewed by subscribers
* Only viewable if a subscriber is subscribed to the bt databox or the zone in which the bt databox is in

## Maintenance

* Records of maintenance are kept for each bt databox

## Parts

* BT databoxes have many parts
* Each part must be checked and serviced every 5 years at a minimum
* Parts can be supplied by more than one supplier
* Being There maintains a record of which parts it has installed into which BT databox

# Assumptions made from the Scenario

* Nothing can be ‘exclusive’ when more than 1 subscriber or contractor can access that data. As such, the word ‘exclusive’ has been removed from all future documentation as it would be impossible to provide ‘exclusive’ data where 2 super platinum subscribers have subscribed zones overlapping or have subscribed to the same BT databox.
* Contracts are different than Subscriptions
* The BT databox website that sells subscriptions would be a type of salesperson with whose account would be managed by the website administrator. The sale through the website would interact with the rest of the system as though it were from a salesperson.
* Maintenance of the BT databoxes would not be able to be carried out by the drone owners due to the complexity of the equipment in the BT databox and the level of calibration required after the repair. Therefore, all databoxes would be sent to a repair shop to be worked on.
* Staff may have multiple roles due to the simplicity of a role and the amount of work that each role may give to each staff member
* A Drone owner might own several drones
* Zones may extend over several countries
* Laws surrounding video and data collection are handled by Being There’s legal team and are out of scope for the database design.
* A mobile application will be made for the device owners to transmit the video and data that their drones collect. This will be considered outside of scope of the database for being there
* The total price of a subscription depends on what the subscriber chooses to subscribe to: the tier of subscription and/or the number of BT databoxes and/or the number of zones the subscriber chooses to subscribe to
* The Video streams will be Stereo-graphic, meaning 2 overlaying videos to create the illusion of depth, not a 3d video. This will allow normal video controls such as pan, tilt and zoom

# Chens Diagram Rational

All of the people interacting with the being there business will have an account with being there. This account will need an identifier, know the name of the person who owns the account, their email address and password so that they log into the system, and their contact information.

There will be 3 types of account: staff, customer or drone owner. It is possible that one person who has an account be many or all of these types of account. A staff member might also want to have access to the video streams therefore being a customer too.

There are 4 roles of staff members: maintenance people, salespeople, administration executives and directors. Due to the range of work of each role, it is possible that a staff member might have several roles. For example a salesperson might also preform maintenance on the BT databoxes between customers, or a director might also be an administration executive.

There are 2 types of customer: subscriber or contractor. A customer can only have one customer type. For example an organization would sign a contract. If an individual at that organization wanted to gain access to a video stream or data for personal use then they would need their own account and become a subscriber. All customers must make payments to keep their subscriptions or as part of the contractual agreement that is signed. Customers might make several payments, especially subscribers who will be making a payment every month.

Maintenance personal do all the maintenance required on the bt databoxes. Maintenance can use parts and all maintenance done on a bt databox must be logged into a report. If more parts are needed, the maintenance personal can order parts from suppliers.

A salesperson works at a store. There they sell subscriptions to subscribers. The subscriptions can be discounted at the salesperson discretion.

Subscriptions give access to video streams and data that being there databoxes gather.

Directors of being there can from time to time adjust the prices of the different subscriptions. There are 4 tiers of subscriptions each which has a increase in price due to the increase in access to data and video stream control. The 4 tiers are: standard, gold, platinum, and super platinum.

If an organization wants access to being there data or video stream’s then they have the facility to sign a contract. An administration executive enters the details of the contract into the system.

Drown owners can own several drones. The databoxes are assigned to a specific drone. Information collected about the drone includes an identifier for it, its maximum operation time and a description of the drone.

A databox operates in a zone. The databox can record a 3d stereographic video stream that subscribers can watch. The stream can be controlled by gold tier subscribers. Platinum tier subscribers (or higher) maintain full rights to the video stream.

The databox can also gather data. The gathered data is recorded onto an external database every 10 seconds. The gathered scientific data is owned by platinum tier or higher subscribers or by contract holders depending on the terms of their contract.

# Chens Conceptual Model

# Chens Diagraming Legend

|  |  |  |
| --- | --- | --- |
| **Name** | **Symbol** | **Description** |
| Entity |  | An identified object or thing that exists the problem space. Relates to other entities and has attributes which describe it. |
| Strong Entity |  | A strong entity is the default type of entity. It can exist by itself. |
| Weak Entity |  | An Entity that is dependent on another entity for its existence. It has an ‘owner’. From the above model, a character cannot exist without a player account. |
| Relationship |  | How entities interact with one another. |
| Weak Relationship |  | A relationship that only exists between a weak and strong entity. Weak entities must have mandatory participation in an identifying relationship to a strong entity |
| Unary Relationship |  | A type of relationship with only 1 entity that participates in 2 roles. Roles are denoted on the relationships. (Note there are none in the diagram above) |
| Binary Relationship |  | A type of relationship which has 2 participant entities. This is the most common type of relationship. |
| Ternary Relationship |  | A type of relationship which has 3 participant entities. |
| N-ary Relationship |  | A type of relationship which has 4 more participant entities. |
| Attribute |  | Characteristic or value that describes an entity or relationship |
| Simple Attribute |  | An attribute that is an atomic value, it cannot be split or simplified any further. |
| Key Attribute |  | Attribute that has been identified as a potential key |
| Primary Key |  | Attribute that identifies an entity |
| Candidate Key |  | Attribute that has been identified that may uniquely identify the entity. Multiple candidate keys can be identified in the conceptual model |
| Multi-Valued Attribute |  | Attribute that can have multiple stored values |
| Composite Attribute |  | An Attribute composed of multiple attributes |
| Complex Attribute |  | Attribute made up of multiple attributes nested inside a composite attribute |
| Derived Attribute |  | An attribute where the value is calculated or determined from another attributes value. For example age is determined from date of birth |
| Mandatory/Total Participation |  | Double line joining an entity to a relationship. Entity must participate in relationship |
| Optional/Partial Participation |  | Single line joining an entity to a relationship. Entity may optionally participate in relationship. |
| Disjoint |  | A type of class inheritance or specialization where entities inherit properties of the super class. Disjointed sub classes do not share amongst each other |
| Overlapping |  | A type of class inheritance or specialization where entities inherit properties from the super class. Overlapping sub classes may share properties with one another. |
| Cardinality | 1 M N | The number of entities that participate in any given relationship. Indicated by the number on the associated |
| Single Cardinality |  | Indicates that only 1 entity participates in the attached relationship. |
| Many Cardinality |  | Indicates that many entities participate in the attached relationship |
| 1 to 1 Relationship |  | A type of relationship where one entity relates to exactly one other entity. |
| 1 to Many Relationship |  | A type of relationship where one entity relates to many other entities |
| Many to Many Relationship |  | A type of relationship where many entities relate to many other entities. The use of M and N denote that the amount of each entity in the relationship may be different. |

# Conceptual Model Documentation

## Documented Entities

|  |  |  |  |
| --- | --- | --- | --- |
| **Entity Name** | **Description** | **Aliases** | **Occurrence** |
| Account | The main account type that all customers, staff and drone owners have a type of. | User | Each account must be a staff member, customer, or drone owner. |
| Staff | The account type that each staff member has. | Staff member  BT Staff | A staff can be a maintenance person, salesperson, administration executive, or director |
| Customer | The account type of all the customers of Being There |  | A customer can be a subscriber or a Contractee |
| Payment | A transfer of money from a customer to being there |  | A payment must be made by a customer |
| Drone Owner | The account type of the owners of the devices that the BT databoxes plug into | Device Owner | A drone owner is a type of account.  A drone owner owns a drone. |
| Maintenance person | The Being There Staff member that services and repairs the BT databoxes | Repairer  Maintenance Staff | A maintenance person is a type of staff.  A maintenance person carries out maintenance on BT drones  A maintenance person orders parts from suppliers |
| Salesperson | The staff member that sells BT subscriptions | Sales | A salesperson is a type of staff.  A salesperson can sell many subscriptions.  A salesperson can apply discounts to their sales. |
| Administration Executive | The BT staff that enters the details of contracts into the system. | Admin | An Administration Executive is a type of staff.  An Administration Executive enters the details of many contracts |
| Director | A director of Being There who sets the prices of all subscriptions | Owner  Manager | A director is a type of staff  A director can change the price of any subscription |
| Subscriber | A type of customer who pays a monthly fee to being three to access video streams and scientific data from BT databoxes |  | A subscriber is a type of customer  A subscriber purchases a subscription |
| Contractee | A type of customer that is an government or private organization that requires video or scientific data from around the world | Contract owner  Contract Holder | A Contractee is a type of customer  A Contractee signs a contract with Being There |
| Maintenance | Scheduled or unscheduled maintenance and repairs that are carried out on BT databoxes | Repair  Calibration  Maintenance | A maintenance is carried out by a maintenance person  A BT databox can have many maintenance logs  Maintenance can use many parts |
| Store | A place where BT sales staff work selling BT subscriptions and maintenance staff service and maintain BT databoxes | Repair Shop  Shop  Being There Store | A store is work at by salespeople |
| Drone | A device that provides the BT databox with a source of power and locomotion. | Device | A drone is owned by a drone owner  A drone connects to a BT databox |
| Discount | A reduction to the cost of the subscription that is applied by the salesperson | Sale | A discount is applied by a salesperson at a sale on a subscription |
| Video Stream | A 360-degree live streamed stereographic video from a BT databox | Stream | A BT databox records the video stream.  A video stream can be viewed by a subscriber to the BT databox  A video stream can be controlled by a gold tier or higher subscriber to the BT databox |
| Subscription | A basic account that Being There sells to the general public. A subscription can be to zero or more BT databoxes and/or zero or more geographical zones. | Basic subscription | A subscription is sold by a salesperson  A subscriber purchases a subscription  A subscriptions price is set by a director  A subscription can view streams of subscribed BT databoxes |
| Gold | A gold tier subscription has all the properties of a basic subscription plus the ability to control the video of the video stream | Gold subscription | A Gold subscription is a type of Subscription  A gold subscription can control a video stream  A gold subscription’s price can be adjusted by a director |
| Platinum | A platinum subscription has all the properties of a gold tier account as well the ownership of rights to the scientific data of the BT databoxes the | Platinum subscription | A Platinum subscription is a type of Subscription  A Platinum subscription owns rights to data collected from BT databoxes  A Platinum subscription’s price can be adjusted by a director |
| Super Platinum | A super platinum subscription has all the properties of a platinum subscription as well as rights to the video streams | Super Platinum Subscription | A Super Platinum subscription is a type of subscription  A super platinum subscription owns the rights to many video streams form BT databoxes  A super platinum subscription’s fee can be adjusted by directors |
| Contract | An agreement between Being There and an organization to provide BT databoxes to geographical locations for a period for a fee. |  | A contract is signed by a Contractee  A contracts details are entered by an Administration Executive  A contract owns the rights to collected scientific data  A contract can cover many BT databoxes and/or many Zones |
| Part | Components of the BT databoxes including all the measuring equipment, cameras and transmission devices. | Component | A part is supplied by a supplier  Many parts compose a BT databox  A part can be ordered by a maintenance person from a supplier  Many parts can be used to maintain a BT databox by a maintenance person |
| Supplier | A company that sells BT databox parts to Being There |  | A supplier supplies can supply many parts  A supplier receives order for parts from a maintenance person |
| BT Databox | The devices which Being There uses to collect data and video streams. |  | A BT databox can record a video stream  A BT databox is composed of many parts  A BT databox can have maintenance preformed on it by a maintenance person using parts  A BT databox transmits scientific data  A BT databox operates in a zone  A BT databox can be covered by a subscription and a contract  A BT databox connects to a drone |
| Scientific data | Recorded data collected from BT databoxes. | Recorded data | Scientific data is transmitted from BT databoxes  The scientific data rights are owned by platinum subscribers and contract holders |
| Zone | A region or area on the planet | Geographical Zone | A zone is operated in by many BT databox  A zone is covered by a contract and/or a subscription |
| Order | A request made to a supplier for new parts | Part order | An order can be made by a maintenance personnel  An order is received by a supplier  An order contain many parts |

## Document Relationships

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Entity Name** | **Cardinality** | **Participation** | **Relationship** | **Participation** | **Cardinality** | **Entity Name** |
| Account | One | Mandatory | Overlap | Optional | One | Staff  Customer  Drone owner |
| Staff | One | Mandatory | Overlap | Optional | One | Maintenance personal  Salesperson  Administration Executive  Director |
| Customer | One | Mandatory | Disjoint | Optional | One | Subscriber  Contractee |
| Maintenance person | One | Optional | Preforms | Mandatory | Many | Maintenance |
| Maintenance person | One | Optional | Makes | Mandatory | Many | Order |
| Order | One | Mandatory | Receive | Optional | One | Supplier |
| Order | One | Mandatory | Contains | Optional | Many | Part |
| Maintenance | Many | Mandatory | Has | Optional | One | BT databox |
| Maintenance | One | Optional | Uses | Optional | Many | Part |
| Part | One | Mandatory | Supplied | Many | Optional | Suppliers |
| Salesperson | Many | Mandatory | Works at | One | Mandatory | Store |
| Salesperson | One | Optional | Sells | Many | Mandatory | Subscriptions |
| Administration Executive | One | Optional | Enters Details | Mandatory | Many | Contract |
| Subscriber | One | Mandatory | Purchases | Mandatory | Many | Subscriptions |
| Contractee | One | Optional | Signs | Mandatory | Many | Contract |
| Customer | One | Optional | Make | Mandatory | Many | Payment |
| Contract | One | Mandatory | Covers | Optional | Many | Zone |
| Contract | One | Mandatory | Covers | Optional | Many | BT Databox |
| Contract | One | Optional | Owns rights | Mandatory | Many | Scientific Data |
| Director | One | Optional | Change price | Optional | One | Subscription |
| Director | One | Optional | Change price | Optional | One | Gold |
| Director | One | Optional | Change price | Optional | One | Platinum |
| Director | One | Optional | Change price | Optional | One | Super Platinum |
| Subscription | Many | Optional | Covers | Optional | Many | BT Databox |
| Subscription | Many | Optional | Covers | Optional | Many | Zone |
| Subscription | Many | Optional | Views | Optional | Many | Video Stream |
| Gold | One | Optional | Controls | Optional | One | Video Stream |
| Platinum | Many | Optional | Owns rights | Optional | Many | Scientific Data |
| Super Platinum | Many | Optional | Owns rights | Optional | Many | Video Stream |
| BT databox | One | Optional | Records | Mandatory | Many | Video Stream |
| BT databox | One | Mandatory | Composed | Mandatory | Many | Part |
| BT databox | One | Optional | Transmit | Mandatory | Many | Scientific Data |
| BT databox | Many | Mandatory | Operates in | Optional | One | Zone |
| BT databox | One | Optional | Connects to | Optional | One | Drone |
| Drone Owner | One | Optional | Owns | Mandatory | Many | Drone |

| Document Attributes | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Entity Name | Attributes | Description | Domain | Aliases | Composite | Derived | Nulls | Key? | Default Value |
| Account | Account ID | Unique Identifier of each account | Number |  | No | No | No | PK |  |
| Name | A name of the contact person for the account | String |  | No | No | No |  |  |
| Email | Email used for account creation and login | String |  | No | No | No |  |  |
| Password | A password needed for account creation and login | String |  | No | No | No |  |  |
| Address | The location of the account holder for mailing purposes | String |  | Yes | No | No |  |  |
| Prefix | The number for unit or apartment if in a building with multiple units | String |  | No | No | Yes |  |  |
| Street Number | The number on the street that the building is | String |  | No | No | Yes |  |  |
| Street name | The name of the street | String |  | No | No | No |  |  |
| Post Code | The post code of the address | Number |  | No | No | No |  |  |
| City | The city of the address | String |  | No | No | No |  |  |
| Country | The country of the address | String |  | No | No | No |  |  |
| Phone Number | The phone number/s of the account holder | String |  | No | No | Yes |  |  |
| Staff | Staff ID | A unique identifier of each staff member | Number |  | No | No | No | PK |  |
| Salary | The monthly salary of each staff member | Currency |  | No | No | No |  | 0 – 100,000 |
| Next of kin | The contact person for the staff member in case of emergency | String |  | No | No | No |  |  |
| Began Employment | The date that the staff member began working for Being There | Date |  | No | No | No |  |  |
| Ended employment | The date that the staff member ending working for Being There | Date |  | No | No | Yes |  |  |
| Role | The position/s that the staff member has at Being There | String |  | No | No | No |  |  |
| Payment | PaymentID | A unique identifier for each payment | Number |  | No | No | No | PK |  |
| Type | The name of the payment type or method | String |  | No | No | No |  |  |
| Payment Date | The date that payment was received by being there | Date |  | No | No | No |  |  |
| Amount | The value of the amount of money received in the payment | Currency |  | No | No | No |  |  |
| Drone | Drone ID | Unique identifier for each drone | Number |  | No | No | No | PK |  |
| Description | A description entered by the owner of the drone on what it can do and would best operate | String |  | No | No | No |  |  |
| Operation Time | The maximum time in seconds that the drone can operate | Number |  | No | No | No |  |  |
| Zone | Zone ID | Unique Identifier for each zone | Number |  | No | No | No | PK |  |
| Conditions | The type of weather conditions that are in the zone | String |  | No | No | No |  |  |
| Country | The countries that the zone covers | String |  | No | No | No |  |  |
| Coordinates | The list of coordinates that dictates where the zone is | Number |  | Yes | No | No |  |  |
| Longitude | The Longitude’s in degrees of each zone | Number |  | Yes | No | No |  |  |
| Minimum Longitude | The minimum longitude in degrees of each zone | Number |  | No | No | No |  | -180 to 180 |
| Maximum Longitude | The maximum longitude in degrees of each zone | Number |  | No | No | No |  | -180 to 180 |
| Latitude | The Latitudes in degrees of each zone | Number |  | Yes | No | No |  |  |
| Minimum Latitude | The minimum latitude in degrees of each zone | Number |  | No | No | No |  | -90 to 90 |
| Maximum Latitude | The maximum latitude in degrees of each zone | Number |  | No | No | No |  | -90 to 90 |
| Contract | Contract ID | A unique identifier of each contract | Number |  | No | No | No | PK |  |
| Start date | The date that the contact was signed | Date |  | No | No | No |  |  |
| End date | The date the contract ends | Date |  | No | No | No |  |  |
| Value | The value in dollar amount of the contact | Currency |  | No | No | No |  |  |
| Subscription | Total Price | The calculated value of the subscription | Currency |  | No | Yes | No |  |  |
| Gold | Price | The value of the tier level | Currency |  | No | No | No |  |  |
| Platinum | Price | The value of the tier level | Currency |  | No | No | No |  |  |
| Super Platinum | Price | The value of the tier level | Currency |  | No | No | No |  |  |
| Scientific Data | Data ID | A Unique identifier for each collected scientific data | Number |  | No | No | No | PK |  |
| Longitude | The longitude in degrees of where the data was collected | Number |  | No | No | No |  | -180 to 180 |
| Latitude | The latitude of where the data was collected | Number |  | No | No | No |  | -90 to 90 |
| Altitude | The altitude in meters of where the data was collected | Number |  | No | No | No |  | 0 – 100,000,000 |
| Temperature | The temperature in degrees Celsius at the collection | Number |  | No | No | No |  | -220 to 200 |
| Ambient light strength | The ambient light strength in at collection | Number |  | No | No | No |  |  |
| Recoding Time | The date and time when the data was recoded | Date/Time |  | No | No | No |  |  |
| Store | Store ID | A unique identifier for each store | Number |  | No | No | No | PK |  |
| Name | The store’s name | String |  | No | No | No |  |  |
| Address | The location of the store for mailing purposes | String |  | Yes | No | No |  |  |
| Prefix | The number for unit or office if in a building with multiple units | String |  | No | No | Yes |  |  |
| Street Number | The number on the street that the store is | String |  | No | No | Yes |  |  |
| Street name | The name of the street where the store is | String |  | No | No | No |  |  |
| Post Code | The post code of the address where the store is | Number |  | No | No | No |  |  |
| City | The city of the address where the store is | String |  | No | No | No |  |  |
| Country | The country of the address | String |  | No | No | No |  |  |
| Phone Number | The phone number of the store | String |  | No | No | No |  |  |
| Video Stream | Stream ID | Unique Identifier of each stream | Number |  | No | No | No | PK |  |
| Start Time | The time the video stream starts | Time |  | No | No | No |  |  |
| End Time | The time the video stream ends | Time |  | No | No | Yes |  |  |
| Length | The total length of the video in seconds | Number |  | No | No | Yes |  |  |
| BT Databox | Databox ID | Unique identifier for each databox | Number |  | No | No | No | PK |  |
| First operated | Date of when the databox first went into service | Date |  | No | No | No |  |  |
| Next Scheduled Service | The date that bt databox is next to be serviced/maintained | Date |  | No | No | No |  |  |
| IP rating | The ingress protection rating of the BT databox | String |  | No | No | No |  |  |
| Maintenance | Maintenance ID | The unique identifier for each maintenance record | Number |  | No | No | No | PK |  |
| Report | A maintenance report of all the work that was done | String |  | No | No | No |  |  |
| Date | The date the maintenance was preformed | Date |  | No | No | No |  |  |
| Part | PartID | A unique identifier for each part | Number |  | No | No | No | PK |  |
| Part Name | The name of each part | String |  | No | No | No |  |  |
| Description | A description of each part | String |  | No | No | No |  |  |
| Cost | The cost of the part | Currency |  | No | No | No |  |  |
| Supplier | Supplier ID | A unique identifier for each supplier | Number |  | No | No | No | PK |  |
| Supplier name | The name of the supplier | String |  | No | No | No |  |  |
| Contact Person | The name of the person to contact at the supplier to make an order or enquiry | String |  | No | No | No |  |  |
| Email | Email address for the supplier to make order or enquiries through | String |  | No | No | No |  |  |
| Address | The address of the supplier | String |  | No | No | Yes |  |  |
| Phone number | The phone number of the supplier | String |  | No | No | Yes |  |  |
| Order | OrderID | Unique identifier for each order | Number |  | No | No | No | PK |  |
| Date | Date on which the order was placed | Date |  | No | No | No |  |  |
| Relationship Name | Attributes | Description | Domain | Aliases | Composite | Derived | Nulls | Key? | Default Value |
| Sells | Percent Discount | The discount applied to a sale | Number |  | No | No | No |  | 0 |
|  | Date | The date of the sale of the subscription | Date |  | No | No | No |  |  |
| Control | Pan | The Degrees of rotation the camera is rotated away from zero | Number |  | No | No | No |  | 0 to 360 |
| Tilt | The Degrees of tilt the camera is rotated | Number |  | No | No | No |  | -30 to 210 |
| Zoom | The amount of zoom the camera is zoomed in | Number |  | No | No | No |  | 1 to 5 |
| Covers | Price | Value of the added zones or BT databoxes to the subscription | Currency |  | No | No | No |  |  |

# Normalization

The process of Normalization takes data in a relation or table and splits it in such a way that it reduces replicated data and dependencies across the formed relations. By completing normalization dependencies are removed, anomalies are removed, and data integrity is improved.

Edgar Codd first came up with Normalization as part of his relational model. He developed First, second and third normal form. Raymond F. Boyce later added to the Boyce-Codd normal form later.

The purpose of normalization is to eliminate redundancy of data, avoid anomalies, and to store data independently from how it is entered into the database.

There are 3 types of anomalies that can occur when data is modified in a database. Data is modified in 1 of 3 ways in a database; updating, inserting or deleting. The anomalies get their names from those methods of data modification.

The update anomaly occurs when a record is updated in one part of the database, but the same pieces of information are not updated in other parts where the same data is recorded or linked. If the database is queried for a piece of data, it might have multiple returns to the query where only one return was expected.

The insert anomaly occurs when data is put into the database, however there is incorrect fields for that data to go into. Most commonly this could be as simple as a spelling error, but in worse cases this could be the addition of an entirely new column not in the relation.

The delete anomaly occurs when data is deleted from the database, however part or all the data remains orphaned in the database. It is not fully removed and is saved somewhere else.

## Standard Notation

Standard Notation Format is a way of describing a relation in the simplest way possible, without the use of graphics of tables. It simplifies the database to tables and the columns that they contain.

Name (Field1, Field2, Field3)

By displaying the relation in the simple way, it allows the process of normalization to be shown clearly and where the dependencies and anomalies are.

## Unnormalized Form

The unnormalized form is a table design that contains repeating groups of data. To represent this in the standard notation the table is given a name and all fields inside that table are comma separated.

tableName(field1, field2, field3, (repeatingField4, repeatingField4), field5)

This data is gathered from reports or forms that a business may be using to share data internally or externally.

A primary key is identified in the unnormalized form by underlining it. It is used to uniquely identify the relation. If there are many identifying fields, then multiple fields may be underlined.

The data stored in a relation in the unnormalized form is very similar to an object or tuple’s in OO languages like JavaScript. The format of the relation can be expressed as a tuple and manipulated as such. It is hard to extrapolate upon how an OO language could interact with a database language based on the similarities.

## First Normal Form (1NF)

A relation or table can be said to be in first normal form if each of the values in the data base are atomic or having the repeating groups removed. The standard notion for this would be:

tableOne(field1, field2, field3) tableTwo(field4, field5)

The repeating data is now divided off into its own table with its own primary key.

There are a few ways to divide data in the unnormalized form to take it to 1NF. The options are to either make another table with all the repeating data, or to make another column in the same table for the repeated data. By making a new table, it may make it easier to continue the normalization process, but for 1NF either is fine.

## Second Normal Form (2NF)

For a relation or table to be in 2NF it needs to already be in 1NF and it needs to have no ‘functional dependencies’ which is where the whole process of normalization starts to lose any sort or sense to me. All the sources just describe this as being ‘not functionally dependent’ yet never going on to explain what that means in plain English. Sources talk about prime and non-prime attributes without explaining what these are. It makes no sense how this is different than 3NF or how if you have conceptually modelled correctly you would get to this point and still have ‘functional dependencies.

With the same data structure, I have found that different people make different assumptions to get to 2NF.

In no model can I find any reason why or where stopping at 2NF makes any sense. The more reasonable approch I can see would be to strictly follow the conceptual modelling rules with an understanding of 3NF and BCNF then double check your work with 3NF or BCNF. This method to me

The only logical and simple way to describe this is that for a relation to be in 2NF it needs to be

* In 1NF
* Only have 1 primary key
* Possibly have Foreign keys linking to other primary keys of other relations
* Each column needs to answer yes to the following question “Does this column serve to describe what the primary key identifies?” (Wenzel, 2019)

## Third Normal Form (3NF)

For a form to be in 3NF it must be in 2NF and contain no ‘transitive dependencies. A transitive dependency is when a column does not rely on the primary key but relies on a non primary key attribute as well as the primary key. In that case it “transits” the non-primary key attribute to get to the dependency on the primary key. In this case another table must be created and a foreign key to the newly created table added to the original table.

Third normal form is entirely logical and while models go into making it complex, it hardly needs to be. Logically, every column should rely on the primary key. If not, there should be another table.

## Boyce-Codd Normal Form (BCNF)

Most if not all 3NF should already be in BCNF. A relation that is in 1NF, 2NF and 3NF and in which every determinant is a candidate key ie Every determinant is a key.

If a relation is in 3NF and has only one candidate key, or only single-attribute candidate keys, then it is in BCNF.

## Fourth Normal Form 4NF

A relation that is in BCNF and does not contain any non-trivial multi-valued dependencies.

# Conceptual to Logical Mapping Rules

The following are the set of rules that are followed when converting the conceptual model to the logical model. While there is cross over, I have referred to entities being in the conceptual model and tables being in the logical model.

* Entities
  + Each entity becomes a table in the logical model. Names remain the same
* Attributes
  + Each attribute becomes an attribute in the corresponding table with the following additional rules
    - Composite attributes become 2 or more attributes
    - Simple attributes remain the same
    - Multi-valued attributes become their own tables. They contain the primary key of their parent table as a foreign key.
* Keys
  + The candidate keys or primary keys in the conceptual model become the primary key in the logical model if they meet the following criteria
    - It is minimal
    - It is stable
    - It is meaningful
  + Primary keys are labeled PK
  + Foreign Keys are labeled FK
  + Composite keys on join tables or elsewhere are labeled CK
  + Composite keys can be 2 or more foreign keys
* Relationships
  + One to one
    - A foreign key can be placed in either table relating to the primary key in the other table. It is not important to the model which table gets the foreign key. However, if there is a more “important” table, then it should get the foreign key of the “lesser” table
  + One to many
    - The primary key from the entity that participates many times in the relationship is put into the table of the entity that participates 1 time in the relationship as a foreign key
  + Many to many
    - A new ‘join’ table must be made to resolve a many to many relationships. The primary key from each participating table is placed into the new table as foreign keys. The foreign keys together become a primary key, also known as a composite key
  + Relationships with Attributes
    - A new table is created with the attributes that the relationship had in the conceptual model as well as foreign keys to the tables for all the matching participant entities
  + Super Class/Sub class
    - Option 1 (Cleanest most logical option): Create a table for the super class and give that table all the super class entity attributes. Create tables for each of the sub classes and give each table its matching attributes. Create relationships between the super class table each of the sub class tables
    - Option 2: Create a table for each sub class that includes all the attributes of the super class, and the super class is removed
    - Option 3: Create 1 table containing all the attributes of all the entities, super class and sub class. Remove the sub class entities.

# Crows Foot ERD Legend

|  |  |  |
| --- | --- | --- |
| Name | Symbol | Description |
| Table |  | A relation in the logical ER model. |
| Table name |  | Displays the tables name |
| Primary Key | PK | Primary keys are the unique identifying attribute of the table |
| Foreign Key | FK | Foreign keys are tables that are linked to the table |
| Data type |  | Shows the data type for each attribute in the table |
| Attribute |  | A value that describes the relation, including the key type (if any) and data type |
|  |  |  |
| Notation for Relationships |  |  |
| 1 and only 1 |  | A mandatory participation type. 1 and only 1 row in the table is in the relationship |
| 1 or many |  | A mandatory participation type. 1 or many rows in the table participate in the relationship |
| 0 or 1 |  | An optional participation type. Zero or many rows in the table can participate in the relationship |
| 0 or Many |  | An optional participation type. Zero or one rows in the table can participate in the relationship. |
| Role |  | Identifies how each relation or table is related to one another |

# Rational for ERD

I started the logical diagram by brining over the account entity and made it a table in the logical model. Arguably one of the most important attributes is the Account ID, as it ends up being the primary key for all the sub classes of account.

The address for the account was separated into its own table. As well, the post code and country separated into their own tables. This was to normalize the database, as several rows might have the same post code or more likely country. By bringing these into their own table, it will be far easier to enforce referential integrity.

The staff, customer and drone owner entities also neatly flowed through to the logical diagram. Each of these entity’s retains the account ID as a foreign key and is the primary key for each of these tables.

I have chosen to use the superclass/subclass mapping rule for all the disjoint/overlap unions in the diagram. This is to follow the same convention and to simplify the mapping in my mind. Also, it allows me to ensure that every entity to table has been made and that both the logical and conceptual diagrams can be similar in layout.

The Payment entity also maps directly over to a table and brings all the attributes. It includes a foreign key to the account type.

The Drone entity maps over to a table in the logical diagram. It includes a foreign key reference to the drone owner table as a drown owner could own many drones.

The subscriber and Contractee entities map to their own tables in logical diagram. Each has the primary and foreign key account ID which links back to the account that they own. To note though, the foreign key on these tables links to the primary key of the customer table.

The Staff role table is created as a join table between the staff table and the different types of staff. This is because each staff member might have 1 or more roles. Each of the staff types gets its only primary key of each tables namesake.

To avoid any chance of having a fan or chasm trap, the maintenance person can make orders for parts, thus requiring a new table here being the order table. That way, each part can be ordered by a maintenance person then used to complete a maintenance job. Each order might contain several line items and therefore links to both the supplier and part table. The part supplier table ensures that there is no traps that are created. Each part can be used in a maintenance job, be ordered individually and supplied by a supplier. While the order table isn’t on the original document brief, I felt that it fits in nicely with the requirements. Otherwise parts somehow magically materialize for being there.

Each maintenance record has a join table to part via maintenance part. I did consider this unnecessary but then realized that each part might be used on several different bt databoxes and avoided that error. The join table between part and bt databox was also created to avoid these traps.

The store entity comes into the logical model as its own table with the entities from the conceptual model. A join table is created between salesperson and store, to maintain normalization.

The sale entity is made from the relationship sale that has attributes. Discount is removed to its own table. Subscription comes through from the conceptual model as well.

For the tiers of subscription, I have maintained the subclass/super class structure as I believe this to be the easiest to understand. It also allows the relationships between the tables to only go to the tier that it relates to such as video stream view, video stream controller, ownership of data rights and owns video rights. The subscription ID is the primary key for each of the different tier of subscription level. It is both a primary and foreign key. Subscription has join tables that connect the subscription to the things that the subscriber subscribes to: subscription bt databox and subscription zone.

The BT databox comes through from the logical model. It has many join tables coming off it to the other entities in the conceptual model that also come through to the logical model. BT databox stream, bt databox data, btdatabox zone, subscription databox, contracted bt databox are all the join tables that join the databox to the other tables in the logical model.

BT databox stream and scientific data both come through from the logical model as well.

Price change expands on the relationship in the conceptual model and I’ve included a few extra attributes that have been realized in the logical model, previous price and new price, so that there can be a record of the old prices.

Contract comes through to the logical model. It has 3 join tables as well that link it to the rest of the diagram: contract scientific data, contracted zone, and contracted bt databox.

The zone entity comes through from the conceptual model. Its complex attributes are broken down to individual attributes of the zone. The Conditions multivalued attributes is separated into its own table. A join table is created between conditions and zone. A join table links zones to countries.

In the work in milestone 3 I realized that a bunch of tables where unnecessary, some foreign keys were missed, other tables have been added. So really everything has to have been done 3 times. I don’t care anymore about documenting them. Just look at the diagrams everything is there. I don’t have the time to write about them all as I just did the work to try and keep up with the due dates.

# Logical ERD

# Data Dictionary

## Entities

This table documents the Entities in the database, with their size and expected growth over time.

|  |  |  |  |
| --- | --- | --- | --- |
| **Entity Name** | **Start Volume** No. of rows loaded at the beginning | **Growth** e.g. no growth / % per year | **Comments** |
| Account | 562,100 | 10% | An account for every staff member, contract holder and drone owner. |
| Address | 563,100 | 10% | An address for every account, store, and supplier |
| Post Code | 250,000 | 10% | Assuming that there will be some cross over of addresses in the same postal code |
| Country | 196 | 0% | The number of countries is set for earth, barring any major political changes |
| Staff | 1000 | 5% | A majority of staff would be in sales and/or maintenance |
| Customer | 502,000 | 5% | 500,000 customers, 2000 contracts |
| Payment | 502,000 | 1200% | Assuming payments will be made monthly and that the system has been operating for 1 month |
| Drone Owner | 40,000 | 7% | Some owners might have several drones |
| Drone | 50,000 | 4% | Made up numbers |
| Contractee | 2000 | 5% | As per brief |
| Subscriber | 500,000 | 8% | As per brief |
| Contract | 2000 | 5% | As per brief |
| Contracted Zone | 10,000 | 5% | Each contract is likely to have several zones |
| Contracted BT Databox | 12,000 | 5% | Each contract having several BT Databoxes |
| Contract Scientific Data | 400,000 | 10000% | Many databoxes in a contract sending data every second of operation. |
| Subscription BT Databox | 1,000,000 | 4% | Each subscriber on average subscribing to 2 databoxes |
| Subscription Zone | 600,000 | 3% | Each subscriber mainly just subscribing to one zone. |
| Condition | 6 | 1000% | Initial number as per brief. Logical subdivisions might be included to further differentiate conditions |
| Zone Condition | 20,000,000 | 4% | Each zone might have several different conditions |
| Zone | 10,000,000 | 2% | Large initial number of zones that a drone can traverse through, unlikely to get much larger if set well to begin with |
| Zone Country | 100,000,000 | 4% | Large number set, with some zones covering several countries |
| BT Databox Zone | 60,000 | 5% | Each bt databox having a zone and there be some zones that overlap |
| Scientific Data | 186,000,000 | 2500% | Assuming that each databox is used one a week for 30 minutes |
| Owns Video Rights | 100,000 | 4% | Made up numbers |
| Owns Data Rights | 200,000 | 4% | Made up numbers |
| Scientific Data | 250,000,000 | 1337% | Made up numbers |
| BT Databox | 50,000 | 5% | Made up numbers |
| Part | 100 | 5% | Made up numbers |
| Video Stream | 420,000 | 5% | Made up numbers |
| Supplier | 70 | 5% | Made up numbers |
| Director | 10 | 5% | Made up numbers |
| Administration Executive | 500 | 5% | Made up numbers |
| Salesperson | 200 | 5% | Made up numbers |
| Maintenance Person | 290 | 5% | Made up numbers |
| Subscription | 500,000 | 5% | Made up numbers |
| Gold | 100,000 | 5% | Made up numbers |
| Platinum | 2,500 | 5% | Made up numbers |
| Super Platinum | 100 | 5% | Made up numbers |
| Subscription Price Change | 500,000 | 5% | Made up numbers |
| Gold Price Change | 100,000 | 5% | Made up numbers |
| Platinum Price Change | 2,500 | 5% | Made up numbers |
| Super Platinum Price Change | 100 | 5% | Made up numbers |
| BT Databox Part | 100,000 | 5% | Made up numbers |
| Store | 1,000 | 5% | Made up numbers |
| Store Salesperson | 250 | 5% | Made up numbers |
| Sale | 500,000 | 5% | Made up numbers |
| Video Stream Viewer | 3,739,482,745 | 5% | Made up numbers |
| Video Stream Controller | 23,465 | 5% | Made up numbers |
| Maintenance | 98,765,432 | 5% | Made up numbers |
| Maintenance Part | 32,455,345 | 5% | Made up numbers |
| Part Supplier | 150 | 5% | Made up numbers |
| Order | 23,366,548 | 5% | Made up numbers |
| Order Item | 32,455,345 | 5% | Made up numbers |
| Store | 1,000 | 5% | Made up numbers |

## Attributes

This table shows the attributes that make up each entity with a description of each. The data types show how the data will be stored in a database and the length is the size of the data stored. The value range is for pre-set fields and indicates the options available. Validation rules show what criteria data must fulfil to be entered. Default value is the starting point for any data in the table. The null column is to show whether or not the data must be present when entering into a data base. The Key identifies any primary keys, while the Integrity constraints identify those attributes that are either Primary or Foreign keys. The references entity column shows which table a foreign key will reference.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Relation Name | Attribute | Description | Data type | Length | Value range | Validation Rules | Default Value | Nulls | Keys? | References Entity | Integrity Constraints |
| Country | CountryID | The unique identifier for each country | Int |  |  |  |  | No | PK |  |  |
|  | Country | The name of a country | Varchar | 64 |  |  |  | No |  |  |  |
| Zone | ZoneID | A unique identifier for each zone | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | Minimum Latitude | The minimum latitude of the zone | Decimal | (10, 7) | -90 to 90 |  |  | No |  |  |  |
|  | Maximum Latitude | The maximum latitude of the zone | Decimal | (10, 7) | -90 to 90 |  |  | No |  |  |  |
|  | Minimum Longitude | The minimum longitude of the zone | Decimal | (10, 7) | -180 to 180 |  |  | No |  |  |  |
|  | Maximum Longitude | The maximum longitude of the zone | Decimal | (10, 7) | -180 to 180 |  |  | No |  |  |  |
| Condition | ConditionID | A unique identifier for each condition | Integer |  |  |  |  | No | PK |  |  |
|  | Condition Description | A description of the condition | VarChar | 255 |  |  |  | No |  |  |  |
| BT Databox | BTDataboxID | A unique identifier for each bt databox | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | First Operated | The date that the bt databox was first operated | Date |  |  |  |  | Yes |  |  |  |
|  | Next Scheduled Maintenance | The date of the next scheduled maintenance | Date |  |  |  |  | Yes |  |  |  |
|  | IP rating | The ingress protection rating of the bt databox | VarChar | 2 |  |  |  | No |  |  |  |
|  | Latitude | The latitude of the databox | Decimal | (10, 7) |  |  |  | No |  |  |  |
|  | Longitude | The longitude of the databox | Decimal | (10, 7) |  |  |  | No |  |  |  |
| Scientific Data | ScientificDataID | A unique identifier for each | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | Longitude | The longitude at the point of recording | Decimal | (10, 7) | -180 to 180 |  |  | No |  |  |  |
|  | Latitude | The latitude at the point of recording | Decimal | (10, 7) | -90 to 90 |  |  | No |  |  |  |
|  | Altitude | The altitude at the point of recording in meters | Integer |  | 0-100,000,000 |  |  | No |  |  |  |
|  | Temperature | The temperature at the point of recording | Decimal | (5, 2) |  |  |  | No |  |  |  |
|  | Ambient Light Strength | The ambient at the point of recording | Decimal | (11, 4) |  |  |  | No |  |  |  |
|  | Recording Time | The time the recording was taken | DateTime |  |  |  |  | No |  |  |  |
| Part | PartID | A unique identifier for each | Integer |  |  | Unique, Identity |  | No | PK |  |  |
| Part name | The name of each part | VarChar | 64 |  |  |  | No |  |  |  |
| Description | A description of each part | VarChar | 255 |  |  |  | No |  |  |  |
| Cost | The cost of the part | Money |  |  |  |  | No |  |  |  |
| Video Stream | StreamID | A unique identifier for each | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | BTDataboxID | Unique identifier for each databox | Int |  |  |  |  | No | FK | BTDatabox |  |
|  | Start Time | The time that the video stream started | DateTime |  |  |  |  | No |  |  |  |
|  | End Time | The time that the video stream ended | DateTime |  |  |  |  | Yes |  |  |  |
|  | Length | The length in seconds of the video stream | Integer |  |  |  |  | Yes |  |  |  |
| PostCode | PostCodeID | The unique identifier for each post code | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | Post Code | The postal code of the area | VarChar | 16 |  |  |  | No |  |  |  |
|  | City | The city that the post code is in | VarChar | 64 |  |  |  | No |  |  |  |
|  | CountryID | The unique identifier for each country | Int |  |  |  |  | No | FK | Country |  |
| Address | AddressID | The unique identifier for each address | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | Prefix | The number for unit or apartment if in a building with multiple units | VarChar | 16 |  |  |  | Yes |  |  |  |
|  | Street Number | The number on the street that the building is | VarChar | 16 |  |  |  | No |  |  |  |
|  | Street Name | The name of the street of the address | Varchar | 16 |  |  |  | No |  |  |  |
|  | PostCodeID | The unique identifier for each post code | Integer |  |  |  |  | No | FK | PostCode |  |
| Supplier | SupplierID | A unique identifier for each | Integer |  |  | Unique, Identity |  | No |  |  |  |
|  | Supplier Name | The name of the supplier | VarChar | 64 |  |  |  | No |  |  |  |
|  | Contact Person | The name of the person to contact at the supplier to make an order or enquiry | VarChar | 64 |  |  |  | No |  |  |  |
|  | Email | Email address for the supplier to make order or enquiries through | VarChar | 64 |  | %@%.% |  | No |  |  |  |
|  | Address | Unique identifier for each address | Int |  |  |  |  | No |  |  |  |
|  | Phone Number | The phone number of the supplier | VarChar | 64 |  |  |  | No |  |  |  |
| Account | AccountID | Unique number used to identify an Account | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | Name | A name of the contact person for the account | VarChar | 255 |  |  |  | No |  |  |  |
|  | Password | The password for the account | VarChar | 255 |  |  |  | No |  |  |  |
|  | AddressID | The foreign key reference for the address associated with the account | Integer |  |  |  |  | No | FK | Address |  |
|  | Phone Number | The phone number associated with the account | VarChar | 64 |  |  |  | No |  |  |  |
| Staff | StaffID | The unique identifier for each staff member | Integer |  |  | Unique, Identity |  | NO | PK |  |  |
|  | AccountID | The unique identifier for the account that the staff member has | Integer |  |  |  |  | No | FK | Account |  |
|  | Salary | The monthly payment that each staff member receives | Money |  | $0 – 100,000 |  |  | No |  |  |  |
|  | Next Of Kin | The emergency contact person for the staff member | VarChar | 64 |  |  |  | No |  |  |  |
|  | Began Employment | The date that the staff member began working for Being There | Date |  |  |  |  | No |  |  |  |
|  | Ended Employment | The date that the staff member ending working for Being There | Date |  |  |  |  | Yes |  |  |  |
| Director | DirectorID | A unique identifier for each director | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | StaffID | Unique identifier for each staff | Integer |  |  |  |  | No | FK |  |  |
| Administration Executive | AdminExecID | A unique identifier for each admin executive | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | StaffID | Unique identifier for each staff | Integer |  |  |  |  | No | FK |  |  |
| Salesperson | SalespersonID | A unique identifier for each salesperson | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | StaffID | Unique identifier for each staff | Integer |  |  |  |  | No | FK |  |  |
| Maintenance person | MaintencepersonID | A unique identifier for each maintenance person | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | StaffID | Unique identifier for each staff | Integer |  |  |  |  | No | FK |  |  |
| Customer | CustomerID | The unique identifier for each customer | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | AccountID | The unique identifier for each account that the customer has | Integer |  |  |  |  | No | FK | Account |  |
| Payment | PaymentID | The unique identifier for each payment | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | Type | The name of the payment type or method | VarChar | 16 |  |  |  | No |  |  |  |
|  | Payment Date | The date that payment was received by being there | Date |  |  |  |  | No |  |  |  |
|  | Amount | The value of the amount of money received in the payment | Money |  |  |  |  | No |  |  |  |
|  | CustomerID | The customer who made the payment | Integer |  |  |  |  | No | FK | Customer |  |
| Drone Owner | DroneOwnerID | The unique identifier for each drone owner | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | AccountID | The unique identifier of each account | Integer |  |  |  |  | No | FK | Account |  |
| Drone | DroneID | The unique identifier of each Drone | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | DroneOwnerID | The unique identifier for each drone owner | Integer |  |  |  |  | No | FK |  |  |
|  | Description | A description of the drone and it functionality | Varchar | 255 |  |  |  | No |  |  |  |
|  | Operation Time | The maximum time in seconds that the drone can be operated for | Integer |  |  |  |  | No |  |  |  |
| Contractee | ContracteeID | The unique identifier for each Contractee | Integer |  |  | Unique, Identity |  | No | PK |  | \ |
|  | CustomerID | The unique identifier for each Customer | Integer |  |  |  |  | No | FK | Customer |  |
| Subscriber | SubscriberID | The unique identifier for each subscriber | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | CustomerID | The unique identifier for each customer | Integer |  |  |  |  | No | FK | Customer |  |
| Subscription | SubscriptionID | A unique identifier for each subscription | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | SubscriberID | A unique identifier for each subscriber | Integer |  |  |  |  | No | FK | Subscriber |  |
| Gold | GoldID | A unique identifier for each Gold | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | SubscriptionID | A unique identifier for each subscription | Integer |  |  |  |  | No | FK | Subscription |  |
| Platinum | PlatinumID | A unique identifier for each Platinum | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | GoldID | A unique identifier for each subscription | Integer |  |  |  |  | No | FK | Gold |  |
| Super Platinum | SuperPlatinumID | A unique identifier for each Super Platinum | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | PlatinumID | A unique identifier for each Platinum | Integer |  |  |  |  | No | FK |  |  |
| Subscription Price Change | PriceChangeID | A unique identifier for each Subscription Price Change | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | DirectorID | A unique identifier for each Director | Integer |  |  |  |  | No | FK | Director |  |
|  | SubscriptionID | A unique identifier for each Subscription | Integer |  |  |  |  | No | FK | Subscription |  |
|  | Date | The date of the price change | Date |  |  |  |  | No |  |  |  |
|  | Previous price | The previous price before the price change | Money |  |  |  |  | No |  |  |  |
|  | New Price | The new price after the price change | Money |  |  |  |  | No |  |  |  |
| Gold Price Change | PriceChangeID | A unique identifier for each Subscription Price Change | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | DirectorID | A unique identifier for each Director | Integer |  |  |  |  | No | FK | Director |  |
|  | GoldID | A unique identifier for each Gold | Integer |  |  |  |  | No | FK | Gold |  |
|  | Date | The date of the price change | Date |  |  |  |  | No |  |  |  |
|  | Previous price | The previous price before the price change | Money |  |  |  |  | No |  |  |  |
|  | New Price | The new price after the price change | Money |  |  |  |  | No |  |  |  |
| Platinum Price Change | PriceChangeID | A unique identifier for each Subscription Price Change | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | DirectorID | A unique identifier for each Director | Integer |  |  |  |  | No | FK | Director |  |
|  | PlatinumID | A unique identifier for each Platinum | Integer |  |  |  |  | No | FK | Platinum |  |
|  | Date | The date of the price change | Date |  |  |  |  | No |  |  |  |
|  | Previous price | The previous price before the price change | Money |  |  |  |  | No |  |  |  |
|  | New Price | The new price after the price change | Money |  |  |  |  | No |  |  |  |
| Super Platinum Price Change | PriceChangeID | A unique identifier for each Subscription Price Change | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | DirectorID | A unique identifier for each Director | Integer |  |  |  |  | No | FK | Director |  |
|  | SuperPlatinumID | A unique identifier for each SuperPlatinum | Integer |  |  |  |  | No | FK | SuperPlatinum |  |
|  | Date | The date of the price change | Date |  |  |  |  | No |  |  |  |
|  | Previous price | The previous price before the price change | Money |  |  |  |  | No |  |  |  |
|  | New Price | The new price after the price change | Money |  |  |  |  | No |  |  |  |
| BTDataboxPart | BTDataboxID | A unique identifier for each bt databox | Integer |  |  |  |  | No | FK |  | PK |
|  | PartID | A unique identifier for each part | Integer |  |  |  |  | No | FK |  | PK |
| BTDatabox Zone | BTDataboxID | A unique identifier for each databox | Integer |  |  |  |  | No | FK | BTDatabox | PK |
|  | ZoneID | A unique identifier for each zone | Integer |  |  |  |  | No | FK | Zone | PK |
| Store | StoreID | A unique identifier for each store | Integer |  |  | Unique, Identity |  | No |  |  |  |
|  | Name | The name of the store | VarChar | 64 |  |  |  | No |  |  |  |
|  | AddressID | A unique identifier for each address | Integer |  |  |  |  | No | FK | Address |  |
|  | PhoneNumber | The phone number of the store | VarChar | 32 |  |  |  | No |  |  |  |
| Store Salesperson | StoreID | A unique identifier for each Store | Integer |  |  |  |  | No | FK | Store | PK |
|  | SalespersonID | A unique identifier for each SalesPerson | Integer |  |  |  |  | No | FK | SalesPerson | PK |
| Sale | SalesPersonID | A unique identifier for each | Integer |  |  | Unique, Identity |  | No | FK | SalesPerson | PK |
|  | SubscriptionID | A unique identifier for each subscription | Integer |  |  |  |  | No | FK | Subscription | PK |
|  | Discount Amount | The amount of discount applied to a sale | Real |  |  |  |  | No | FK |  |  |
| Video Stream Viewer | StreamID | A unique identifier for each video stream | Integer |  |  |  |  | No | FK | Video Stream | PK |
|  | SubscriptionID | A unique identifier for each subscription | Integer |  |  |  |  | No | FK | Subscription | PK |
| Video Stream Controller | GoldID | A unique identifier for each Gold | Integer |  |  |  |  | No | FK | Gold |  |
|  | StreamID | A unique identifier for each stream | Integer |  |  |  |  | No | FK | VideoStream |  |
|  | Pan | The Degrees of rotation the camera is rotated away from zero | Decimal | (6, 3) | 0 to 360 |  | 0 | No |  |  |  |
|  | Tilt | The Degrees of tilt the camera is rotated | Decimal | (6, 3) | -30 to 210 |  | 0 | No |  |  |  |
|  | Zoom | The amount of zoom the camera is zoomed in | Decimal | (6, 3) | 1 to 5 |  | 1 | No |  |  |  |
| Maintenance | MaintenanceID | A unique identifier for each maintence | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | MaintenancePersonID | A unique identifier for each maintenance person | Integer |  |  |  |  | No | FK | Maintenance Person |  |
|  | BTdataboxID | A unique identifier for each bt databox | Integer |  |  |  |  | No | FK | BT Databox |  |
|  | Report | A maintenance report of all the work that was done | VarChar | 255 |  |  |  | No |  |  |  |
|  | Date | The date the maintenance was preformed | Date |  |  |  |  | No |  |  |  |
| Maintenance Part | MaintenanceID | A unique identifier for each Maintenance | Integer |  |  |  |  | No | FK | Maintenance | PK |
|  | PartID | A unique identifier for each Part | Integer |  |  |  |  | No | FK | Part | PK |
| Part Supplier | PartID | A unique identifier for each part | Integer |  |  |  |  | No | FK | Part | PK |
|  | SupplierID | A unique identifier for each supplier | Integer |  |  |  |  | No | FK | Supplier | PK |
| Order | OrderID | A unique identifier for each order | Integer |  |  |  |  | No | FK | Order | PK |
|  | MaintenancePersonID | A unique identifier for each maintenance person | Integer |  |  |  |  | No | FK | MaintenancePerson | PK |
| Order Item | OrderID | A unique identifier for each order | Integer |  |  |  |  | No | FK | Order | PK |
|  | PartID | A unique identifier for each part | Integer |  |  |  |  | No | FK | Part | PK |
|  | SupplierID | A unique identifier for each supplier | Integer |  |  |  |  | No | FK | Supplier | PK |
| Zone Country | ZoneID | A unique identifier for each zone |  |  |  |  |  | No | FK | Zone | PK |
|  | CountryID | A unique identifier for each country |  |  |  |  |  | No | FK | Country | PK |
| Zone Condition | ZoneID | A unique identifier for each zone | Integer |  |  |  |  | No | FK | zone | PK |
|  | ConditionID | A unique identifier for each condition | Integer |  |  |  |  | No | FK | condition | PK |
| Subscription Zone | SubscriptionID | A unique identifier for each subscription | Integer |  |  |  |  | No | FK | Subscription | PK |
|  | ZoneID | A unique identifier for each zone | Integer |  |  |  |  | No | FK | Zone | PK |
| Subscription BTDatabox | SubscriptionID | A unique identifier for each subscription | Integer |  |  |  |  | No | FK | Subscription | PK |
|  | BtDataboxID | A unique identifier for each bt databox | Integer |  |  |  |  | No | FK | BT Databox | PK |
| Contract | ContractID | The unique identifier for each contract | Integer |  |  | Unique, Identity |  | No | PK |  |  |
|  | Start Date | The date that the contract was signed between being there and the Contractee | Date |  |  |  |  | No |  |  |  |
|  | End Date | The date that the contract is set to end | Date |  |  |  |  | Yes |  |  |  |
|  | Value | The value the contract signed between | Money |  |  |  |  | No |  |  |  |
|  | Contractee | The unique identifier for the account of the customer who is a Contractee | Integer |  |  |  |  | No | FK | Contractee |  |
|  | Entered By Admin | The unique identifier for the Administrative executive who entered the details of the contract | Integer |  |  |  |  | No | FK | Administration Executive |  |
| Contracted BTDatabox | ContractID | A unique identifier for each contract | Integer |  |  |  |  | No | FK | Contract | PK |
|  | BTDataboxID | A unique identifier for each btdatabox | Integer |  |  |  |  | No | FK | BTDatabox | PK |
| Contracted Zone | ContractID | A unique identifier for each Contract | Integer |  |  |  |  | No | FK | Contract | PK |
|  | ZoneID | A unique identifier for each Zone | Integer |  |  |  |  | No | FK | Zone | PK |
| Contract Scientific Data | ContractID | A unique identifier for each contract | Integer |  |  |  |  | No | FK | Contract | PK |
|  | ScientificDataID | A unique identifier for each scientific data | Integer |  |  |  |  | No | FK | Scientific data | PK |
|  | isDeleted | A binary value for if the data point is deleted or not | Bit |  |  |  |  | No |  |  |  |
| Owns Data Rights | ScientificDataID | A unique identifier for each scientific data | Integer |  |  |  |  | No | FK | Scientific Data | PK |
|  | SubscriptionID | A unique identifier for each subscription | Integer |  |  |  |  | No | FK | Subscription | PK |
| Owns Video Rights | StreamID | A unique identifier for each stream | Integer |  |  |  |  | No | FK | Video Stream | PK |
|  | SubscriptionID | A unique identifier for each subscription | Integer |  |  |  |  | No | FK | Subscription | PK |

# NaLER Analysis

This NaLER analysis breaks down the developed logical model into a Natural Language equivalent. The constructed sentences are broken into Attributes and Relationships.

## Attribute sentences

s1 Each Account is uniquely identified by one AccountID Account

s2 One Account (AccountID) must have one Name

s3 One Account (AccountID) must have one Email

s4 One Account (AccountID) must have one Password

s5 One Account (AccountID) must have one AddressID

s6 One Account (AccountID) must have one PhoneNumber

s7 Each Staff is uniquely identified by one StaffID

s8 One Staff (StaffID) must have one Salary

s9 One Staff (StaffID) must have one Next of Kin

s10 One Staff (StaffID) must have one Began Employment

s11 One Staff (StaffID) may have one Ended Employment

s12 One Staff (StaffID) must have one Role

s13 Each Payment is uniquely identified by one PaymentID

s14 One Payment (PaymentID) must have one Type

s15 One Payment (PaymentID) must have one Payment Date

s16 One Payment (PaymentID) must have one Amount

s17 One Payment (PaymentID) must have one Customer

s18 Each Drone Owner is uniqely identified by one AccountID, DroneID

s19 Each Drone Owner(AccountID, DroneID) must have one AccountID

s20 Each Drone Owner(AccountID, DroneID) must have one DroneID

s21 Each Address is uniqely identified by one AddressID

s22 One Address (AddressID) may have one Prefix

s23 One Address (AddressID) must have one StreetNumber

s24 One Address (AddressID) must have one StreetName

s25 One Address (AddressID) must have one PostCodeID

s26 Each Customer is uniquely idntified by one AccountID

s27 Each Drone is uniquely identified by one DroneID

s28 One Drone (DroneID) must have one Description

s29 One Drone (DroneID) must have one Operation Time

s30 Each Contractee is uniquely identified by one AccountID

s31 Each Subscriber is uniquely identified by one AccountID

s32 Each Contract is uniquely identified by one ContractID

s33 One Contract (ContractID) must have one Start Date

s34 One Contract (ContractID) may have one End Date

s35 One Contract (ContractID) must have one Value

s36 One Contract (ContractID) must have one Contractee

s37 One Contract (ContractID) must have one Entered By Admin

s38 Each PostCode is uniquely identified by one PostCodeID

s39 One PostCode (PostCodeID) must have one PostCode

s40 One PostCode (PostCodeID) must have one City

s41 One PostCode (PostCodeID) must have one Country

s42 Each Conutry is uniquely identified by one Country

s43 Each Staff role is uniquely identified by AccountID, RoleID

s44 Each Staff role(AccountID, RoleID) must have one AccountID

s45 Each Staff role(AccountID, RoleID) must have one RoleID

s46 Each Director is uniquely identified by one DirectorID

s47 Each Administration Executive is uniquely identified by one AdminExecID

s48 Each Salesperson is uniquely identified by one SalespersonID

s49 Each Maintenance Person is uniquley identified by one MaintenancePersonID

s50 Each StoreSalesPeople is uniquely identified by one StoreID, SalsepersonID

s51 Each StoreSalesPerson (StoreID, SalsepersonID) must have one StoreID

s52 Each StoreSalesPerson (StoreID, SalsepersonID) must have one SalespersonID

s53 Each Store is uniquely identified by one StoreID

s54 Each Store (StoreID) must have one Name

s55 Each Store (StoreID) must have one Address

s56 Each Store (StoreID) must have one PhoneNumber

s57 Each VideoStream is uniquely identified by one VideoStreamID

s58 Each VideoStream(VideoStreamID) must have one Start Time

s59 Each VideoStream(VideoStreamID) may have one End Time

s60 Each VideoStream(VideoStreamID) may have one Length

s61 Each Sale is uniquely identified by one SalespersonID, SubscriptionID

s62 Each Sale (SalespersonID, SubscriptionID) must have one SalespersonID

s63 Each Sale (SalespersonID, SubscriptionID) must have one SubscriptionID

s64 Each Sale (SalespersonID, SubscriptionID) may have one DiscountAmount

s65 Each Discount is uniquely identified by one DiscountAmount

s66 Each Subscription is uniquely identified by one SubscriptionID

s67 Each Subscription (SubscriptionID) must have one AccountId

s68 Each Subscription (SubscriptionID) must have one TotalPrice

s69 Each Gold is uniquely identified by one SubscriptionID

s70 Each Gold (SubscriptionID) must have one TotalPrice

s71 Each Platinum is uniquely identified by one SubscriptionID

s72 Each Platinum (SubscriptionID) must have one TotalPrice

s73 Each Super Platinum is uniquely identified by one SubscriptionID

s74 Each Super Platinum (SubscriptionID) must have one TotalPrice

s75 Each Video stream viewer is uniquely identified by one StreamID, SubscriptionID

s76 Each Video stream viewer (StreamID, SubscriptionID) must have one StreamID

s77 Each Video stream viewer (StreamID, SubscriptionID) must have one SubscriptionID

s78 Each Video stream Controller is uniquely identified by one StreamID, SubscriptionID

s79 Each Video stream Controller (StreamID, SubscriptionID) must have one StreamID

s80 Each Video stream Controller (StreamID, SubscriptionID) must have one SubscriptionID

s81 Each Video stream Controller (StreamID, SubscriptionID) must have one Pan

s82 Each Video stream Controller (StreamID, SubscriptionID) must have one Tilt

s83 Each Video stream Controller (StreamID, SubscriptionID) must have one Zoom

s84 Each Owns Data Rights is uniquely identified by one ScientificDataID, SubscriptionID

s85 Each Owns Data Rights (ScientificDataID, SubscriptionID) must have one ScientificDataID

s86 Each Owns Data Rights (ScientificDataID, SubscriptionID) must have one SubscriptionID

s87 Each Owns Video Rights is uniquely identified by one StreamID, SubscriptionID

s88 Each Owns Video Rights (StreamID, SubscriptionID) must have one StreamID

s89 Each Owns Video Rights (StreamID, SubscriptionID) must have one SubscriptionID

s90 Each Price Change is uniquely identified by one DirectorID, SubscriptionID

s91 Each Price Change (DirectorID, SubscriptionID) must have one DirectorID

s92 Each Price Change (DirectorID, SubscriptionID) must have one SubscriptionID

s93 Each Price Change (DirectorID, SubscriptionID) must have one Date

s94 Each Price Change (DirectorID, SubscriptionID) must have one PreviousPrice

s95 Each Price Change (DirectorID, SubscriptionID) must have one NewPrice

s96 Each Contract Scientific Data is uniquely identified by one ContractID, ScientificDataID

s97 Each Contract Scientific Data (ContractID, ScientificDataID) must have one ContractID

s98 Each Contract Scientific Data (ContractID, ScientificDataID) must have one ScientificDataID

s99 Each Contracted BTDatabox is uniquely identified by one ContractID, BTDataboxID

s100 Each Contracted BTDatabox (ContractID, BTDataboxID) must have one ContractID

s101 Each Contracted BTDatabox (ContractID, BTDataboxID) must have one BTDataboxID

s102 Each Subscription Zone is uniquely identified by one SubscriptionID, ZoneID

s103 Each Subscription Zone (SubscribedID) must have one SubscriptionID

s104 Each Subscription Zone (SubscribedID) must have one ZoneID

s105 Each Zone is uniquely identified by one ZoneID

s106 Each Zone (ZoneID) must have one ZoneConditionID

s107 Each Zone (ZoneID) must have one CountryID

s108 Each Zone (ZoneID) must have one Minimum Latitude

s109 Each Zone (ZoneID) must have one Maximum Latitude

s110 Each Zone (ZoneID) must have one Minimum Longitude

s111 Each Zone (ZoneID) must have one Maximum Longitude

s112 Each Zone Condition is uniquely identified by one ZoneID, ConditionID

s113 Each Zone Condition (ZoneID, ConditionID) must have one ZoneID

s114 Each Zone Condition (ZoneID, ConditionID) must have one ConditionID

s115 Each Condition is uniquely identified by one ConditionID

s116 Each Condition (ConditionID) must have one ConditionID

s117 Each Condition (ConditionID) must have one Conditions

s118 Each Condition (ConditionID) must have one Condition description

s119 Each Zone Country is uniquely identified by one ZoneID, Country

s120 Each Zone Country (ZoneID, Country) must have one ZoneID

s121 Each Zone Country (ZoneID, Country) must have one CountryID

s122 Each Scientific Data is uniquely identified by one ScientificDataID

s123 Each Scientific Data (ScientificDataID) must have one ScientificDataID

s124 Each Scientific Data (ScientificDataID) must have one Longitude

s125 Each Scientific Data (ScientificDataID) must have one Latitude

s126 Each Scientific Data (ScientificDataID) must have one Altitude

s127 Each Scientific Data (ScientificDataID) must have one Temperature

s128 Each Scientific Data (ScientificDataID) must have one Ambient Light Strength

s129 Each Scientific Data (ScientificDataID) must have one Recording Time

s130 Each BT Databox Data is uniquely identified by one BTDataboxDataID

s131 Each BT Databox Data(BTDataboxDataID) must have one BTDataboxID

s132 Each BT Databox Data(BTDataboxDataID) must have one ScientificDataID

s133 Each BT Databox Data(BTDataboxDataID) must have one Date

s134 Each BT Databox Data(BTDataboxDataID) must have one Time

s135 Each BT Databox is uniquely identified by one BTDataboxID

s136 Each BT Databox (BTDataboxID) must have one BTDataboxID

s137 Each BT Databox (BTDataboxID) must have one First Operated

s138 Each BT Databox (BTDataboxID) must have one Next Scheduled Maintanence

s139 Each BT Databox (BTDataboxID) must have one IP rating

s140 Each BT Databox Stream is uniquely identified by one BTDatabox, StreamID

s141 Each BT Databox Stream(BTDatabox, StreamID) must have one BTDataboxID

s142 Each BT Databox Stream(BTDatabox, StreamID) must have one StreamID

s143 Each Video Stream is uniquely identified by one VideoStreamID

s144 Each Video Stream(VideoStreamID) must have one StreamID

s145 Each Video Stream(VideoStreamID) must have one Start Time

s146 Each Video Stream(VideoStreamID) may have one End Time

s147 Each Video Stream(VideoStreamID) may have one Length

s148 Each Maintenance is uniquely identified by one MaintenanceID

s149 Each Maintenance (MaintenanceID) must have one MaintenanceID

s150 Each Maintenance (MaintenanceID) must have one MaintencepersonID

s151 Each Maintenance (MaintenanceID) must have one BTdataboxID

s152 Each Maintenance (MaintenanceID) must have one Report

s153 Each Maintenance (MaintenanceID) must have one Date

s154 Each Maintenance Part is uniquely identified by one MaintenanceID, PartID

s155 Each Maintenance Part (MaintenanceID, PartID) must have one MaintenanceID

s156 Each Maintenance Part (MaintenanceID, PartID) must have one PartID

s157 Each BT Databox Part is uniquely identified by one BTDataboxID, PartID

s158 Each BT Databox Part (BTDataboxID, PartID) must have one BTDataboxID

s159 Each BT Databox Part (BTDataboxID, PartID) must have one PartID

s160 Each Part is uniquely identified by one PartID

s161 Each Part (PartID) must have one PartID

s162 Each Part (PartID) must have one Part name

s163 Each Part (PartID) must have one Description

s164 Each Part (PartID) must have one Cost

s165 Each Order is uniquely identified by one OrderID

s166 Each Order (OrderID) must have one OrderID

s167 Each Part Supplier is uniquely identified by one PartID, SupplierID

s168 Each Part Supplier (PartID, SupplierID) must have one PartID

s169 Each Part Supplier (PartID, SupplierID) must have one SupplierID

s170 Each Supplier is uniquely identified by one SupplierID

s171 Each Supplier (SupplierID) must have one SupplierID

s172 Each Supplier (SupplierID) must have one Supplier Name

s173 Each Supplier (SupplierID) must have one Contact Person

s174 Each Supplier (SupplierID) must have one Email

s175 Each Supplier (SupplierID) must have one Address

s176 Each Supplier (SupplierID) must have one Phone Number

s177 Each Contracted Zone is uniquely identified by one ContractID, ZoneID

s178 Each Contracted BTDatabox Zone(ContractedID) must have one ContractID

s179 Each Contracted BTDatabox Zone(ContractedID) must have one ZoneID

s180 Each OrderItem is uniquely identified by one OrderItemID

s181 Each Order (OrderID) must have one SupplierID

s182 Each Order (OrderID) must have one PartID

s183 Each Subscription Databox is uniquely identified by one SubscriptionID, DataboxID

s184 Each Subscription Databox (SubscriptionID, DataboxID) must have one SubscriptionID

s185 Each Subscription Databox (SubscriptionID, DataboxID) must have one BTDataboxID

## Relationship sentences

s186 One Account must have one and only one Address

s187 One Address may have one Account

s188 One Account may have zero or one Customer

s189 One Customer must have one and only one Account

s190 One Account may have zero or one Drone Owner

s191 One Drone Owner must have one and only one Account

s192 One Account may have one Staff

s193 One Staff must have one and only one Account

s194 One Customer may have many Payment

s195 One Payment must have one and only one Customer

s196 One Drone Owner may have many Drone

s197 One Drone must have one and only one Drone Owner

s198 One Customer may have One Contractee

s199 One Contractee may have One Customer

s200 One Customer may have One Subscriber

s201 One Subscriber must have One Customer

s202 One Contractee must have one or many Contract

s203 One Contract must have One Contractee

s204 One Contract may have many Contract BTDatabox

s205 One Contract BTDatabox must have One Contract

s206 One Contract must have one or many Contract Scientific Data

s207 One Contract Scientific Data must have One Contract

s208 One Contract must have One Administration Executive

s209 One Administration Executive may have many Contract

s210 One Staff must have one or many Staff Role

s211 One Staff Role must have One Staff

s212 One Staff Role may have one Director

s213 One Director must have One Staff Role

s214 One Staff Role may have One Administration Executive

s215 One Administration Executive must have One Staff Role

s216 One Staff Role may have One Salesperson

s217 One Salesperson must have One Staff Role

s218 One Staff Role may have One Maintenance person

s219 One Maintenance person must have One Staff Role

s220 One Director may have many Price Change

s221 One Price Change must have One Director

s222 One Salesperson must have one or many Store Salesperson

s223 One Store Salesperson must have One Salesperson

s224 One Store Salesperson must have One Store

s225 One Store must have one or many Store Salesperson

s226 One Salesperson may have many Sale

s227 One Sale must have One Salesperson

s228 One Sale may have One Discount

s229 One Discount must have One Sale

s230 One Sale must have One Subscription

s231 One Subscription must have One Sale

s232 One Subscription may have many Video stream Viewer

s233 One Video stream Viewer must have One Subscription

s234 One Video stream may have many video stream viewer

s235 One video stream viewer must have One Video stream

s236 One Subscription may have One Gold

s237 One Gold must have One Subscription

s238 One Gold may have One Platinum

s239 One Platinum must have One Gold

s240 One Platinum may have One Super Platinum

s241 One Super Platinum must have One Platinum

s242 One Subscription may have many Price Change

s243 One Price Change must have One Subscription

s244 One Gold may have One Price Change

s245 One Price Change must have One Gold

s246 One Platinum may have One Price Change

s247 One Price Change must have One Platinum

s248 One Super Platinum may have One Price Change

s249 One Price Change must have One Super Platinum

s250 One Subscription must have one or many Subscription Zone Databox

s251 One Subscription Zone Databox must have One Subscription

s252 One Subcription must have One Subscriber

s253 One Subscriber must have one or many Subcription

s254 One Gold may have many Video stream Controller

s255 One Video stream Controller must have One Gold

s256 One Video stream may have many Video stream Controller

s257 One Video stream Controller must have One Video stream

s258 One Video Stream may have many Owns Video Rights

s259 One Owns Video Rights must have One Video Stream

s260 One Owns Video Rights must have One Super Platinum

s261 One Super Platinum may have many Owns Video Rights

s262 One Platinum may have many Owns Data Rights

s263 One Owns Data Rights must have One Platinum

s264 One Scientific Data may have many Owns Data Rights

s265 One Owns Data Rights must have One Scientific Data

s266 One Scientific Data may have many BT Databox Data

s267 One BT Databox Data must have One Scientific Data

s268 One BT Databox Data must have One BT Databox

s269 One BT Databox may have many BT Databox Data

s270 One Video Stream may have many BT Databox Stream

s271 One BT Databox Stream must have One Video Stream

s272 One BT Databox Stream must have One BT Databox

s273 One BT Databox may have many BT Databox Stream

s274 One BT Databox may have many Maintenance

s275 One Maintenance must have One BT Databox

s276 One BT Databox must have one or many BT Databox Part

s277 One BT Databox Part must have One BT Databox

s278 One BT Databox may have many BT Databox Zone

s279 One BT Databox Zone must have One BT Databox

s280 One BT Databox must have One Drone

s281 One Drone must have One BT Databox

s282 One Subscription Zone must have One Zone

s283 One Zone may have many Subscription Zone

s284 One Subscription Zone must have One Subscription

s285 One Subscription may have many Subscription Zone

s286 One Contracted Zone must have One Zone

s287 One Zone may have many Contracted Zone

s288 One Contracted BTDatabox must have One BTDatabox

s289 One BTDatabox may have many Contracted BTDatabox

s290 One Contract Scientific Data must have One Scientific Data

s291 One Scientific Data must have one or many Contract Scientific Data

s292 One Zone may have many BT Databox Zone

s293 One BT Databox Zone must have One Zone

s294 One Zone must have one or many Zone Country

s295 One Zone Country must have One Zone

s296 One Zone must have one or many Zone Condition

s297 One Zone Condition musthave One Zone

s298 One Zone Condition must have One Condition

s299 One Condition may have many Zone Condition

s300 One Zone Country must have One Country

s301 One Country may have many Zone Country

s302 One Country must have one or many PostCode

s303 One PostCode must have One Country

s304 One PostCode may have One Address

s305 One Address must have One PostCode

s306 One Address may have One Supplier

s307 One Supplier must have One Address

s308 One Supplier may have many Order Item

s309 One Order Item must have One Supplier

s310 One Supplier may have many Part Supplier

s311 One Part Supplier must have One Supplier

s312 One Part may have many Part Supplier

s313 One Part Supplier must have one Part

s314 One Part may have many Maintenance Part

s315 One Maintenance Part must have One Part

s316 One Maintenance may have many Maintenance Part

s317 One Maintenance Part must have One Maintenance

s318 One Maintenance person may have many Order

s319 One Order must have One Maintenance person

s320 One Maintenance person may have many Maintenance

s321 One Maintenance must have One Maintenance person

s322 One Order Item must have One Part

s323 One Part may have many Order Item

s324 One Order must have one or many order item

s325 One order item may have many Order

s326 One order must have one or many order item

s327 One order item may have many order

s328 One Contracted zone must have one Contract

s329 One Contract may have many Contracted zone

s330 One Contracted BTDatabox must have one Contract

s331 One Contract may have many Contracted BTDatabox

s332 One Contract Scientific data must have one Contract

s333 One Contract may have many Contract Scientific data

s334 One Contracted Scientific Data must have one Scientific Data

s335 One Scientific Data may have many Contracted Scientific Data

s336 One Subscription may have many Subscription Databox

s337 One Subscription Databox must have one Subscription

s338 One BTDatabox may have many Subscription Databox

s339 One Subscription Databox must have one BTDatabox

# Transaction Analysis

# References

Atkins, C., & Patrick, J. (2000). NaLER: a natural language method for interpreting entity‐relationship models. *Campus-Wide Information Systems*, *17*(3), 85-93. https://doi.org/10.1108/10650740010326627

Connolly, T. M., & Begg, C. E. (2006). *Database systems : a practical approach to design, implementation and management*. Tpb.

Simsion, G. C., & Witt, G. C. (2005). *Data modeling essentials*. Morgan Kaufmann Publishers.