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Ship Management System

Data and Applications

Project Phase -3

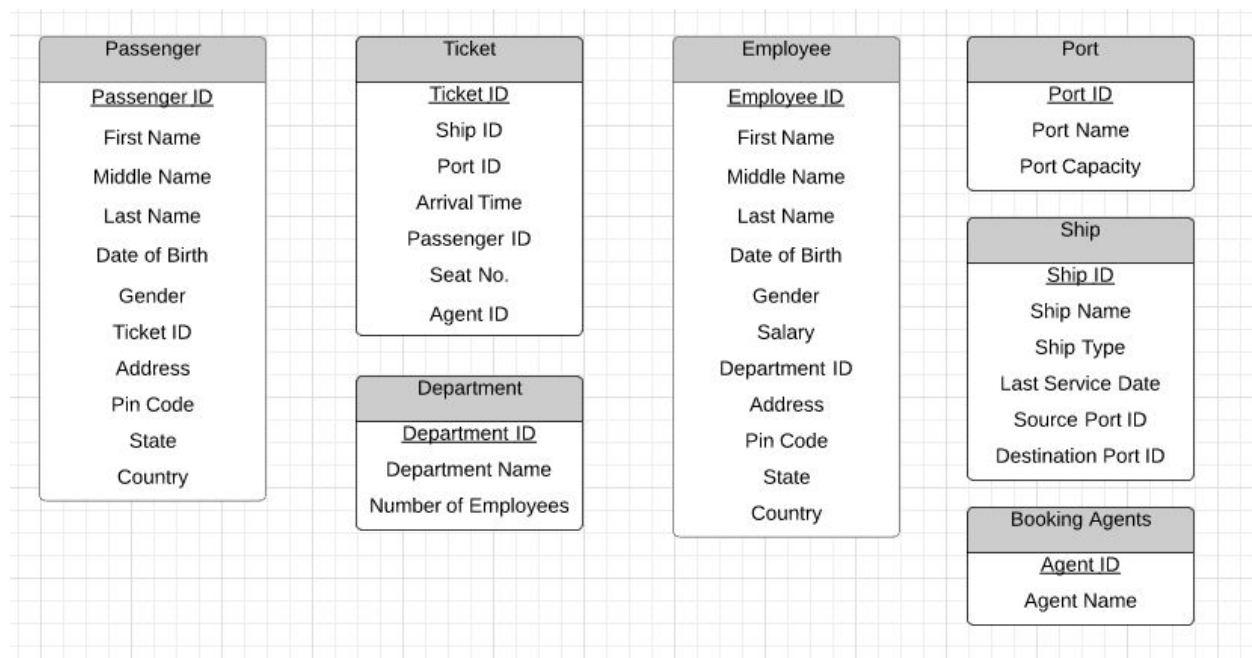
Improvements in ER Model and the System in General

- Removed 'Seat No.' as an Attribute from the Entity Passenger.
- Modified Attribute 'Department Name' of Entity Employee to 'Department ID'
- Added a new Attribute 'Agent ID' in the Entity Ticket.
- Added a new Attribute 'Dependent No.' in the Entity 'Employee Dependent'.
- The Superclass of Drivers, Security and Other Staff Subclasses has been modified from Department to Employee.
- Modified the description of Relationship between Ships and Ports.

ER Model to Relational Model

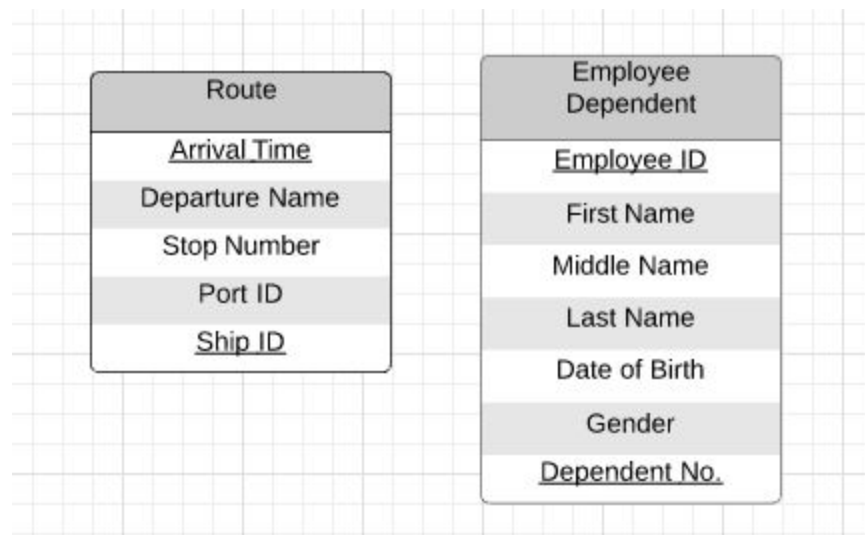
- Step 1: Mapping of Regular Entity Types

For each regular (strong) entity type in the ER schema, we created a relation that includes all the simple attributes of E. For Composite Attributes, only the simple attributes were included. For example: Name was converted to Simple Attributes First Name, Middle Name and Last Name and Full Address was converted to Address, Pin Code, State and Country.



- Step 2: Mapping of Weak Entity Types

For each weak entity type W in the ER schema with owner entity type E, relation R is created which includes all simple attributes (or simple components of composite attributes) of W as attributes of R. Each Relation includes the primary key of owner Entity as a foreign key.



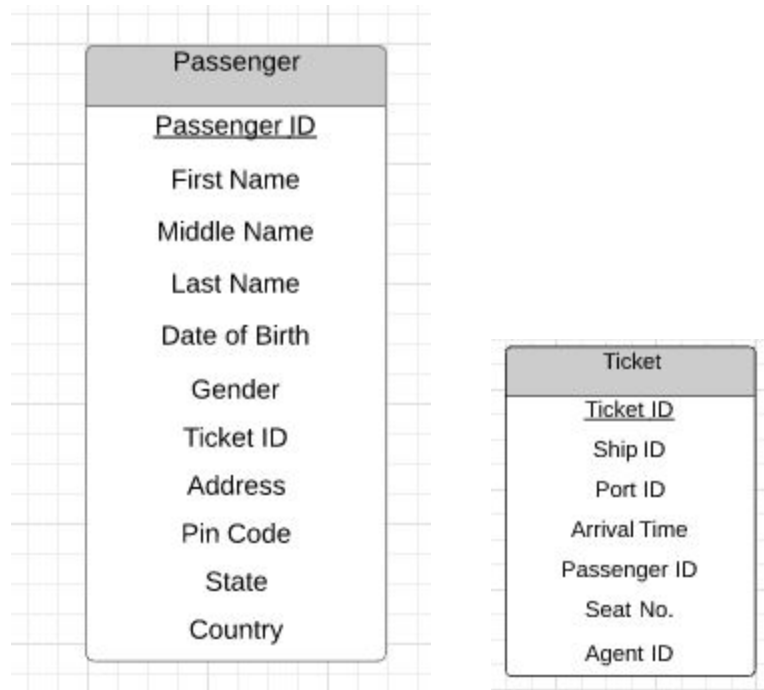
- Step 3: Mapping of Binary 1:1 Relationship Types

Foreign Key Approach

For 'OWNS' Binary 1:1 Relationship type in the ER schema, the primary key of Passenger i.e. Passenger ID was added as a foreign key to the Ticket Relation.

Relationships:

1. Passenger **OWNS** Ticket

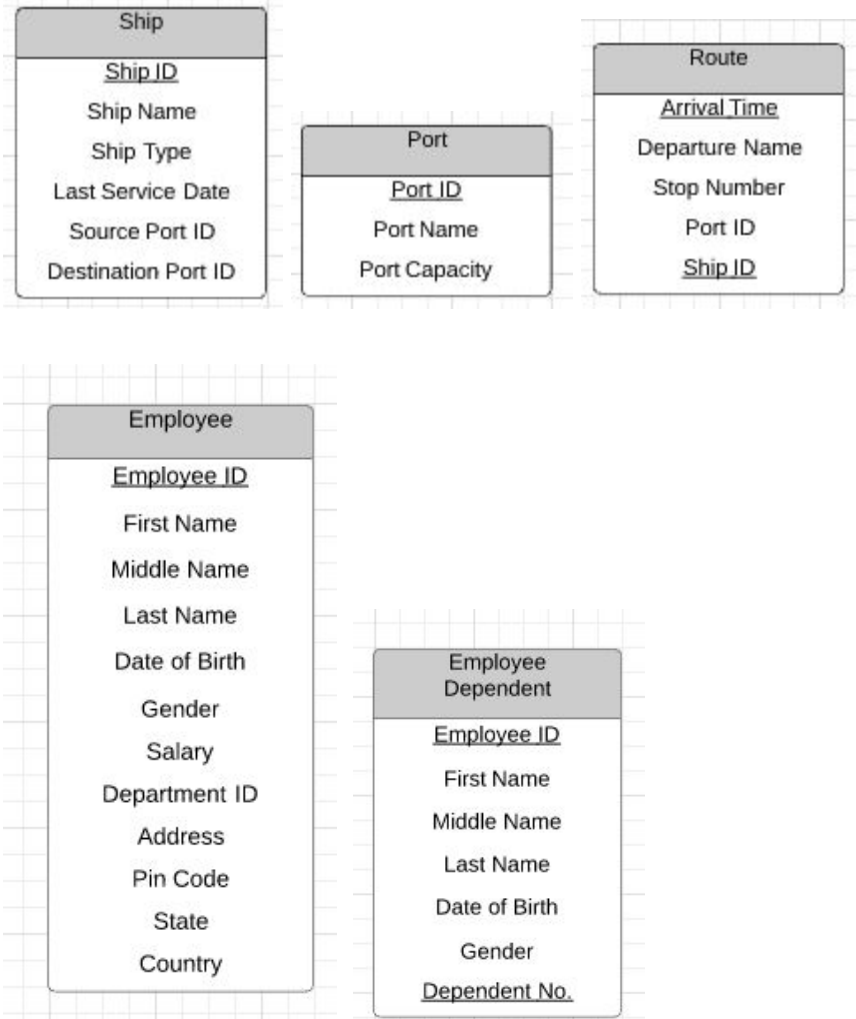


- Step 4: Mapping of Binary 1:N Relationship Types

Foreign Key Approach

Relationships:

1. Ship **STARTS AT** PORT - Primary key of Port was added to Ship.
2. Ship **ENDS AT** PORT - Primary key of Port was added to Ship.
3. Dependent **RELATIVE OF** Employee - Primary key of Employee was added to Dependent.
4. Ship **FOLLOWS** Route - Primary key of ship was added to Route.
5. Employee **WORKS AT** Port - Primary key of Port was added to Employee.

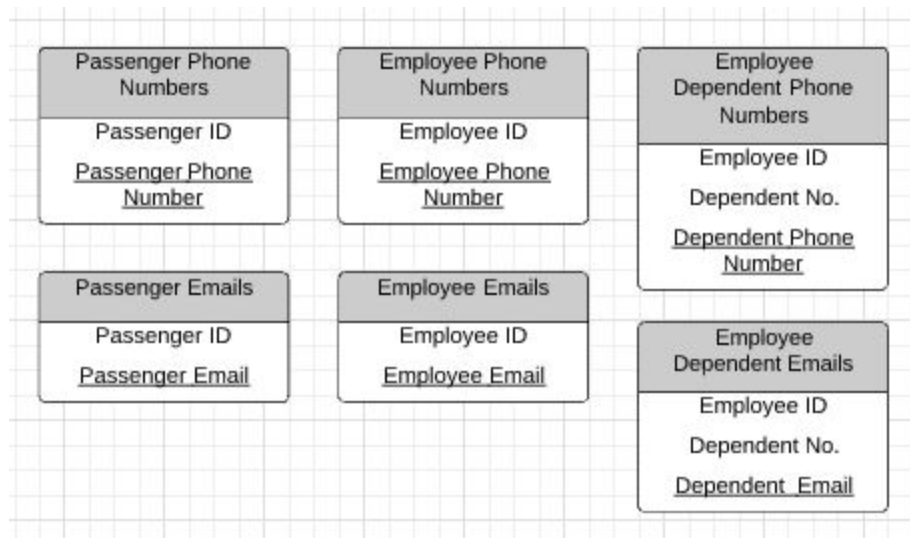


- Step 5: Mapping of Binary M:N Relationship Types

No Such Relationships Exist in our Schema

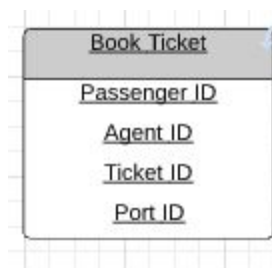
- Step 6: Mapping of Multivalued Attributes

For Multivalued Attributes such as Phone Number and Email, we created new Relations and removed these attributes from the Relations Employee, Employee Dependent and Passenger.



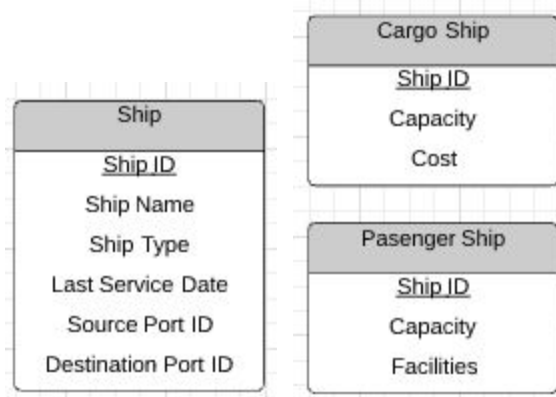
- Step 7: Mapping of N-ary Relationship Types

A new relation Book Ticket is made for Book ticket 4-ary Relationship type which includes the primary key of Passenger, Port, Agent and Ticket as a foreign key attribute.

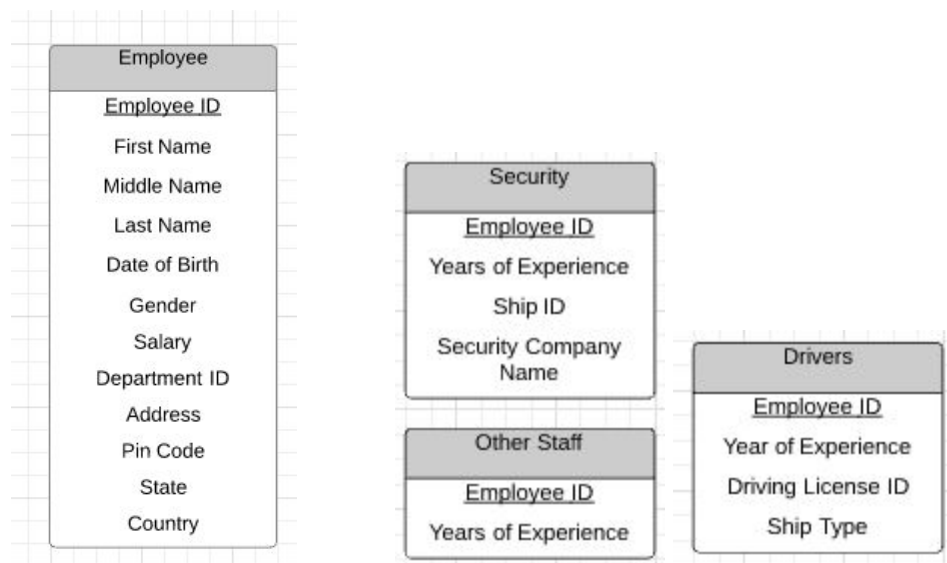


- Step 8 : Mapping Specialization or Generalization

A new relation for subclasses Cargo Ship and Passenger Ship is made which includes the primary key of its superclass Ship (using **Multiple relations-superclasses and subclasses** approach).



A new relation for subclasses Drivers, Security and Other Staff is made which includes the primary key of their superclass Employee (using **Multiple relations-superclasses and subclasses** approach).



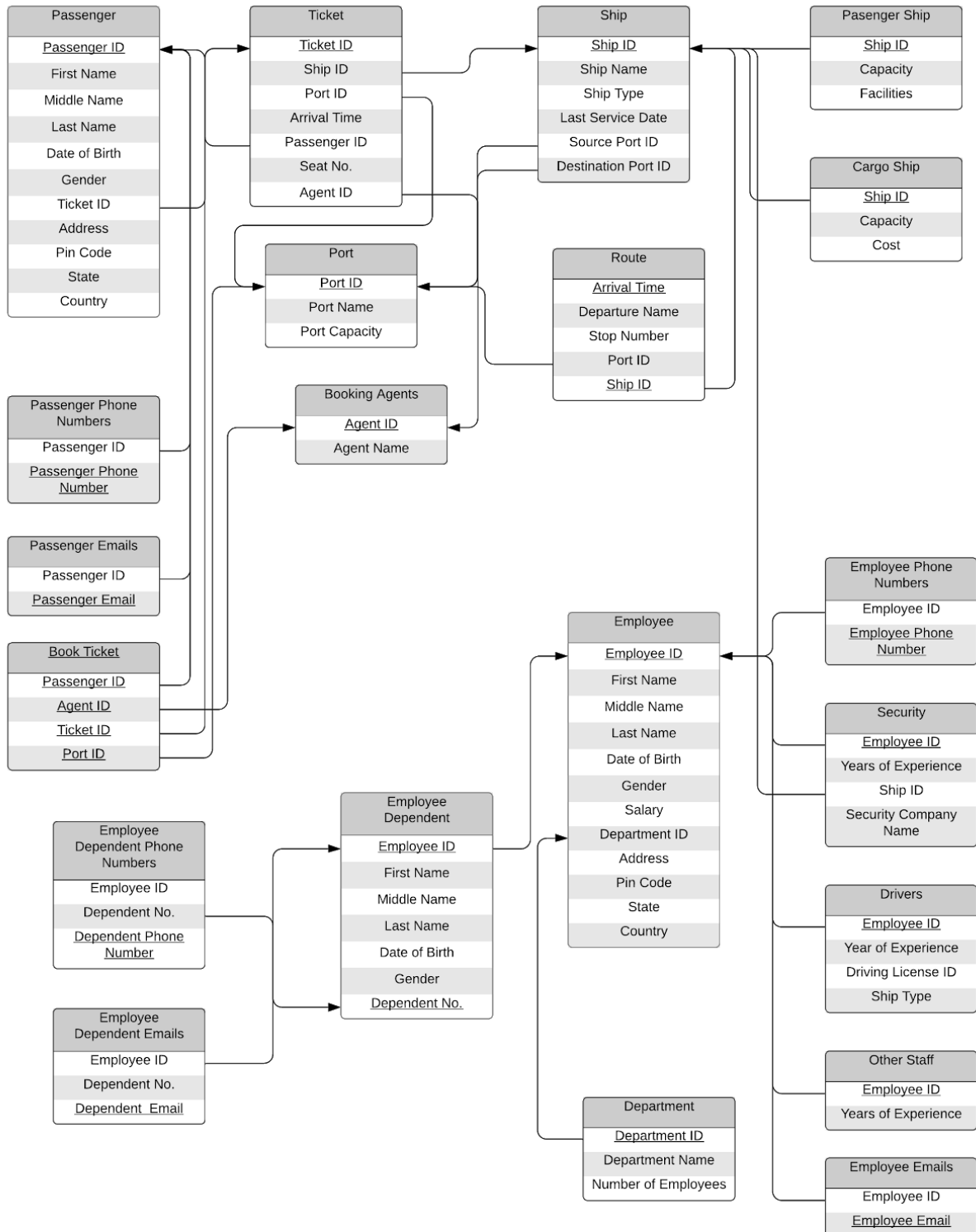
- Step 9: Mapping of Union Types (Categories)

No Union Types Exist in our Schema

P.T.O.

The Relational Model Obtained from the ER

(Note: Some Arrows had to be removed due to constraints on the maximum number of objects that the drawing tool - LucidChart can draw on the free subscription)



Conversion of Relational Model to 1NF

Already in 1NF

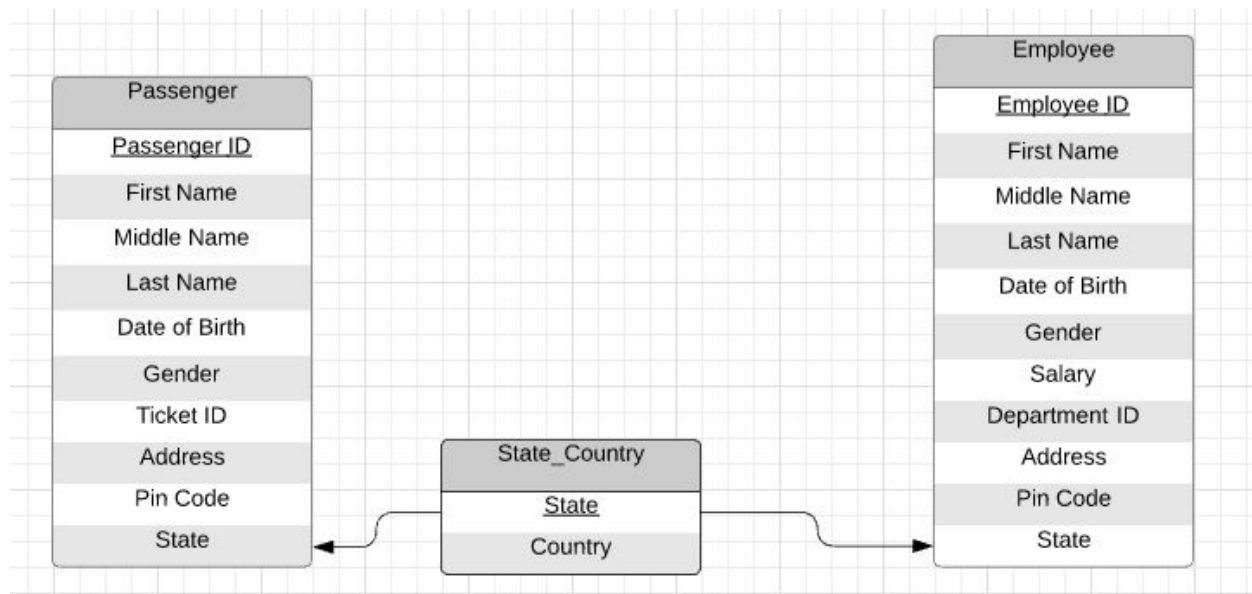
The relational model is already in 1NF as new relations for multivalued attributes were created in Step 6 and Composite attributes were converted to atomic attributes in Step 1.

Conversion of 1NF Relational Model to 2NF

Already in 2NF

The relational model is already in 2NF as it does not have any non-prime attribute that is functionally dependent on any proper subset of any candidate key of the relation.

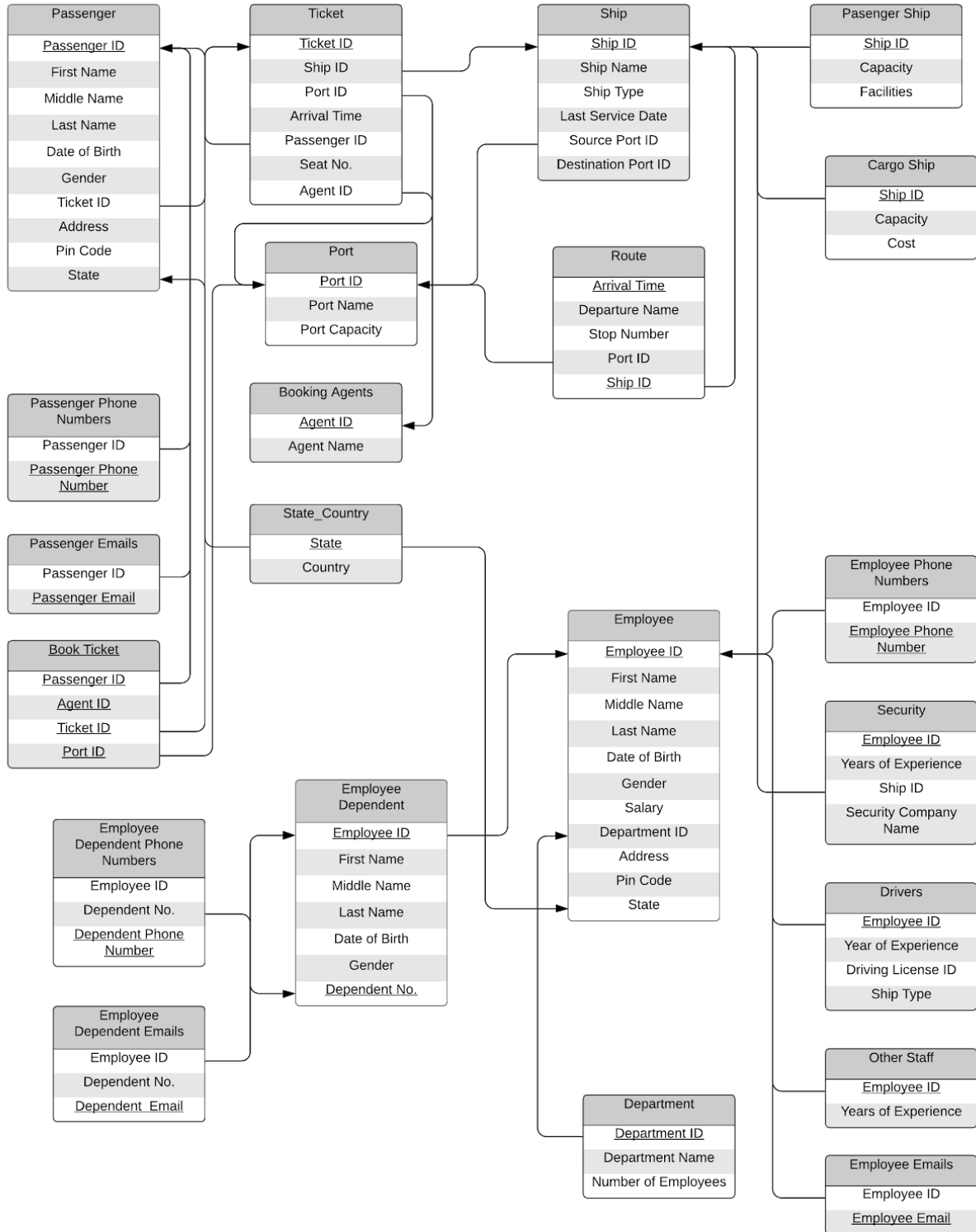
Conversion of 2NF Relational Model to 3NF



In both the Passenger and Employee Relations, the Country was dependent upon the State, and the State was dependent on the Primary Key (Passenger ID/Employee ID), so the Country was transitively dependent on the Primary key which violated the rule of non transitive dependency. So, to convert into 3NF, we made a separate relation for State and Country. Now, the model is in Third Normal Form.

The final 3NF Relational Model

(Note: Some Arrows had to be removed due to constraints on the maximum number of objects that the drawing tool - LucidChart can draw on the free subscription)



Example Tuples for Each Relation to Show a Consistent State of the Final Relational Model

Entity Type	Attributes	Tuple 1	Tuple 2
Passenger	Passenger ID	1111111	1211212
	First Name	Robert	Jennifer
	Middle Name	Paul	Ross
	Last Name	Hendricks	Cooper
	Date of Birth	01-01-2002	10-10-1994
	Gender	Male	Female
	Ticket ID	1234567	7654321
	Address	Room no 112 IIIT Hyderabad	Room no 116 IIIT Haryana
	Pin Code	123456	654321
	State	Goa	Kerala
Ship	Ship ID	12345	23456
	Ship Name	Titan	Virat
	Ship Type	Passenger	Cargo
	Last Service Date	10-04-1912	10-10-2018
	Source Port ID	45678	98765
	Destination Port ID	98765	45678
Cargo Ship	Ship ID	23456	
	Capacity (in TEU)	1000.00	

	Cost (Rupees per TEU)	1000.00	
Passenger Ship	Ship ID	12345	
	Capacity (Number of People)	999	
	Facilities	Swimming Pool, Resort	
Employee	Employee ID	6786786	1233211
	First Name	Penny	Leonard
	Middle Name	S.	
	Last Name	Anniston	Nayyar
	Date of Birth	10-10-2000	01-01-2001
	Gender	Female	Male
	Salary (in Rupees)	100000	110000
	Department ID	1212	1223
	Address	Room no 113 IIIT Hyderabad	Room no 117 IIIT Haryana
	Pin Code	123456	654321
	State	Goa	Kerala
Port	Port ID	45678	98765
	Port Name	Sri Lanka Port	India Port
	Port Capacity (Number of Ships)	100	200
Route	Arrival Time	2005-01-01 00:00:00	2005-01-01 12:00:01
	Departure Time	2005-01-01 00:00:05	NULL
	Stop Number	1	2

	Port ID	45678	98765
	Ship ID	12345	12345
Ticket	Ticket ID	1234567	7654321
	Ship ID	12345	12345
	Port ID	45678	45678
	Arrival Time	2005-01-01 00:00:00	2005-01-01 00:00:00
	Passenger ID	1111111	1211212
Employee Dependent	Employee ID	6786786	1233211
	Dependent No.	1	1
	First Name	Rajesh	Chandler
	Middle Name	S.	
	Last Name	Koothrappali	Bing
	Date of Birth	11-11-1965	12-12-1980
	Gender	Male	Male
Department	Department ID	1212	1223
	Department Name	Drivers	Security
	Number of Employes	1	1
Drivers	Employee ID	6786786	
	Years Of Experience	10	
	Driving License ID	5656565	
	Ship Type	Passenger	
Booking Agents	Agent ID	4566544	
	Agent Name	Paytm	

Security	Employee ID	1233211	
	Years Of Experience	10	
	Ship ID	12345	
	Security Company Name	Protect Securities	
Other Staff	Employee ID		
	Years Of Experience		
Employee Phone Numbers	Employee ID	6786786	1233211
	Phone Number	1234567890	9876543210
Employee Email IDs	Employee ID	6786786	1233211
	Email ID	ytashgdjb@jsaf.com	snfl@hasjfk.co.in
Passenger Phone Numbers	Passenger ID	1111111	1211212
	Phone Number	2222222222	3333333333
Passenger Email IDs	Passenger ID	1111111	1211212
	Email ID	nasafn@msaklf.com	aaasa@gasjdh.com
Employee Dependent Phone Numbers	Employee ID	6786786	1233211
	Dependent Number	1	1
	Phone Number	5656565656	6565656565
Employee Dependent Email IDs	Employee ID	6786786	1233211
	Dependent Number	1	1
	Email ID	akd@haskc.com	nsakfnk@kfla.com
State_Country	State	Goa	Kerala
	Country	India	India
Book Ticket	Ticket ID	1234567	7654321

	Passenger ID	1111111	1211212
	Port ID	45678	45678
	Agent ID	4566544	4566544