Physical Database Design

(Chapter 8)

Physical Database Design Process

- Transformation of logical database design to a physical database design
- Requires a profound shift in topics
  - Significant knowledge of target DBMS required
  - DBA often carries out at least part of physical database design
  - Performance concerns need to be addressed
  - Goal is to produce (generate) SQL DDL to define the database objects (tables, columns, indexes, views, etc.

Skills / Knowledge Required

- Understanding of the logical database design
- Features of the target DBMS, esp. storage and indexing
- DBMS tuning options and trade-offs
- The operating system (OS) on which DBMS will run
- The hardware on which the database server will run
- Physical storage mechanisms available on the particular platform

Inputs to Physical Design

- Logical database design
- Process models, including when and how often rows are added, updated, deleted, retrieved
- Process/Entity (CRUD) Matrix
- Performance requirements
- Target DBMS
- Disk space constraints
- Development schedule
- Data retention requirements
- Data volumes and growth rate

Table Design Process

1. Each normalized relation becomes a table
   - Common exceptions are supertypes and subtypes
2. Each attribute becomes a column in a table, specifying:
   - Unique column name within the table
   - Data type with length/precision/scale as required
   - Whether values are required or not
   - Check constraints
- Primary Key constraint defined on unique identifier
- Unique constraint defined on other candidate keys
- Relationships become referential constraints

Physical Design Process (2)

6. Physical storage specifications added:
   - Tablespace assignment (file group in SQL Server)
   - Consider index organized table (IOT) options
   - Free space
   - Data compression
   - Clustering
7. Specify partitioning for very large tables
8. Alternatively, consider splitting very large tables
9. Set up any required replication
10. Add new tables and/or columns required for audit
11. Physical model can be a subset of the logical model

Physical Design Notes

- Primary key constraint components must be defined as NOT NULL
- Unique constraint components can be NULL (subject to DBMS restrictions)
- Only one primary key constraint per table, but multiple unique constraints are o.k.
- For 1:1 relationships, implement with a referential constraint and a unique constraint on the primary key in one table that was placed as a foreign key in the other table.

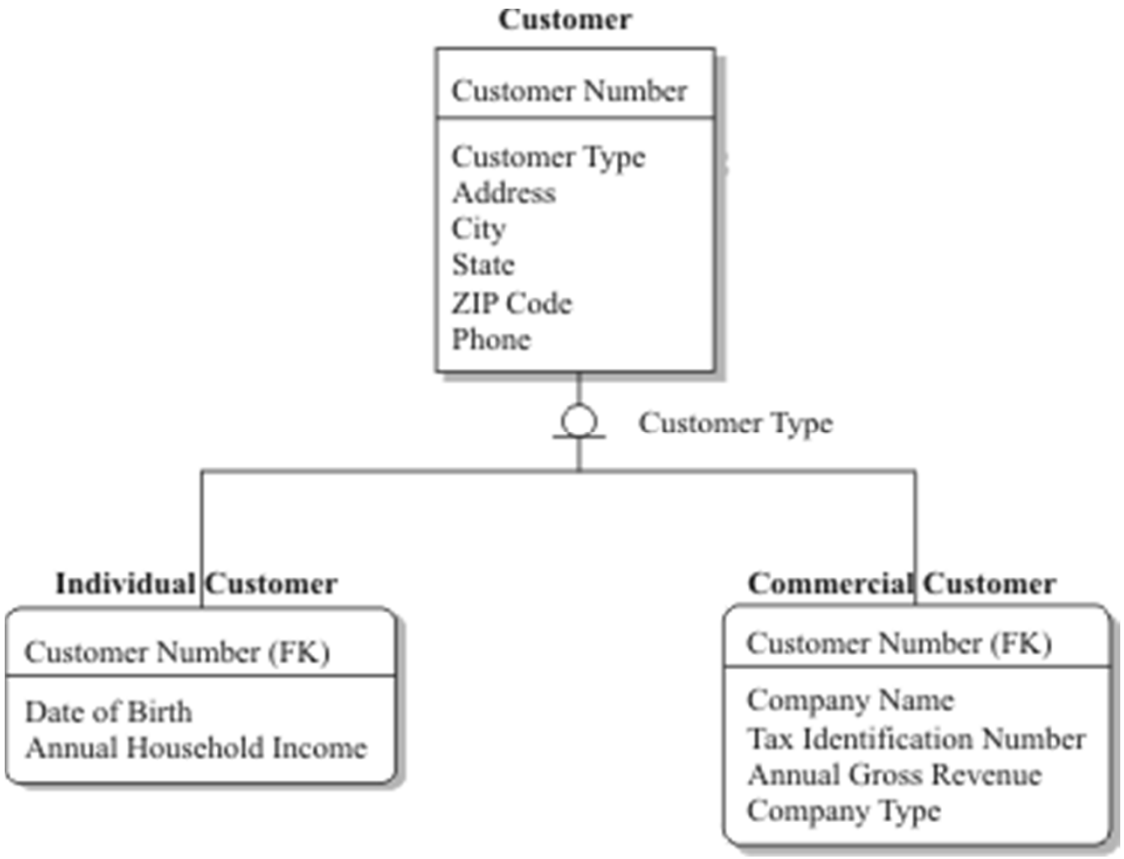
Typical Physical Diagram Differences

- Logical names shifted to all caps with underscores replacing spaces or special characters
- Data types displayed on diagram
- NULL / NOT NULL displayed on diagram
- Optionally, referential constraint names displayed on diagram (in place of verb phrases on logical diagram)
- Views may be shown

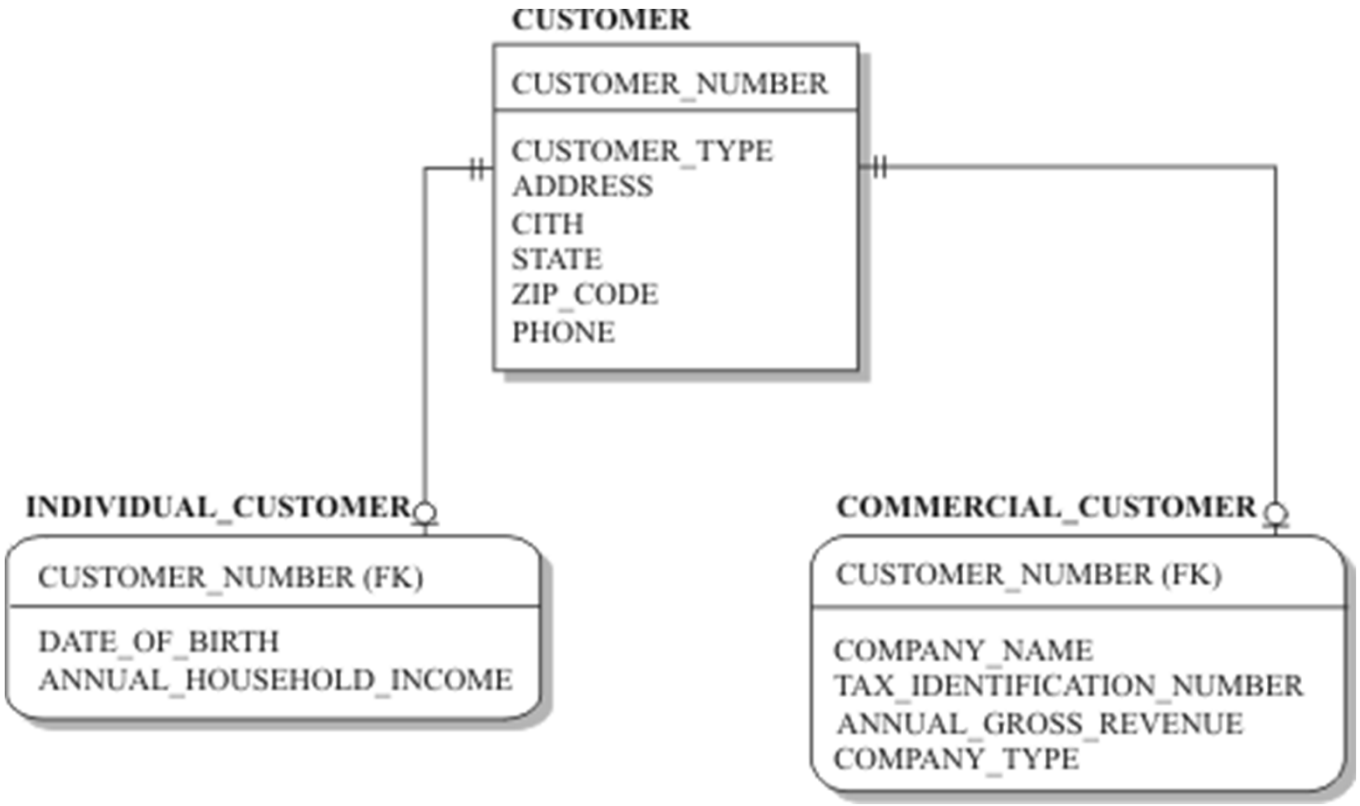
Implementing Supertypes and Subtypes

- Three basic choices (subsequent slide on each):
  - Implement as is (the “three table solution”)
  - Push supertype down into each subtype (the “two table solution”)
  - Roll subtypes up into the supertype (the “one table solution”)

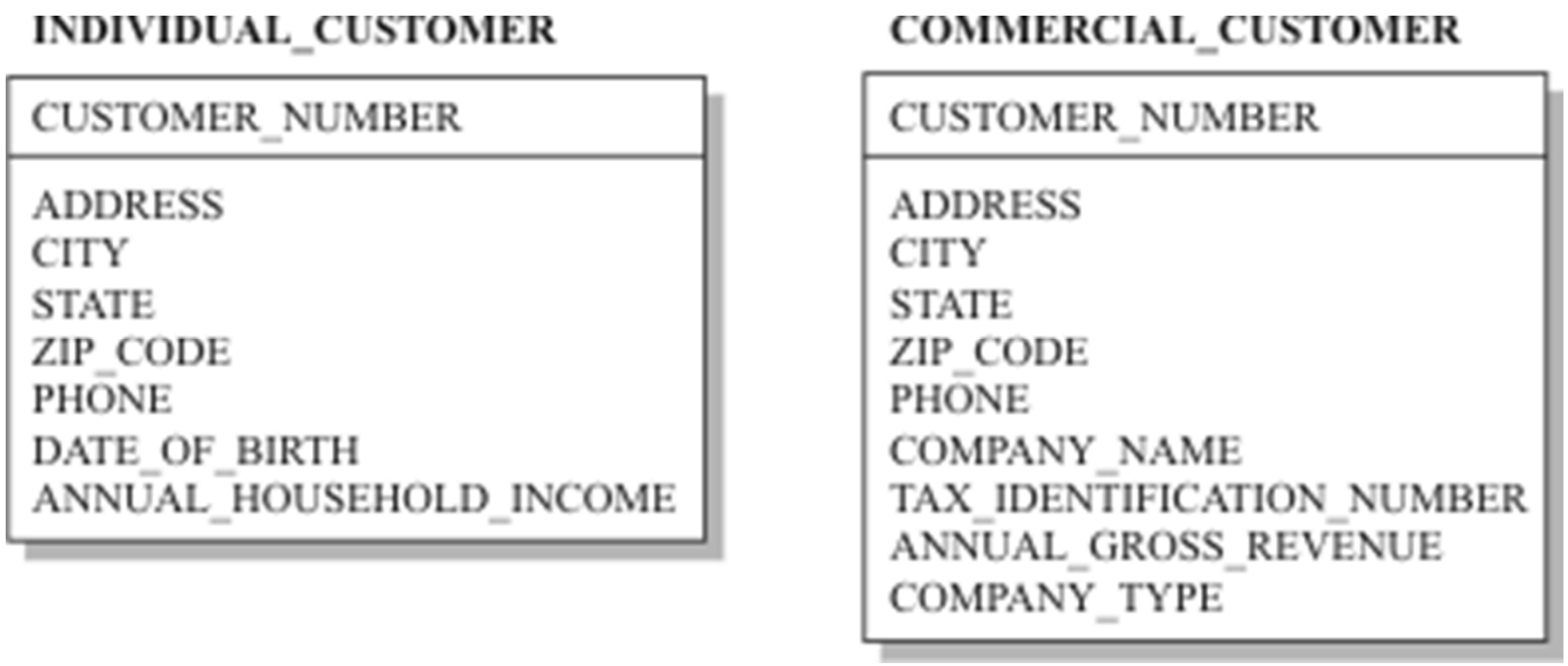
Logical Model



Implement Subtypes As Is



Push Supertype Into Subtypes



Roll Subtypes Into Supertype

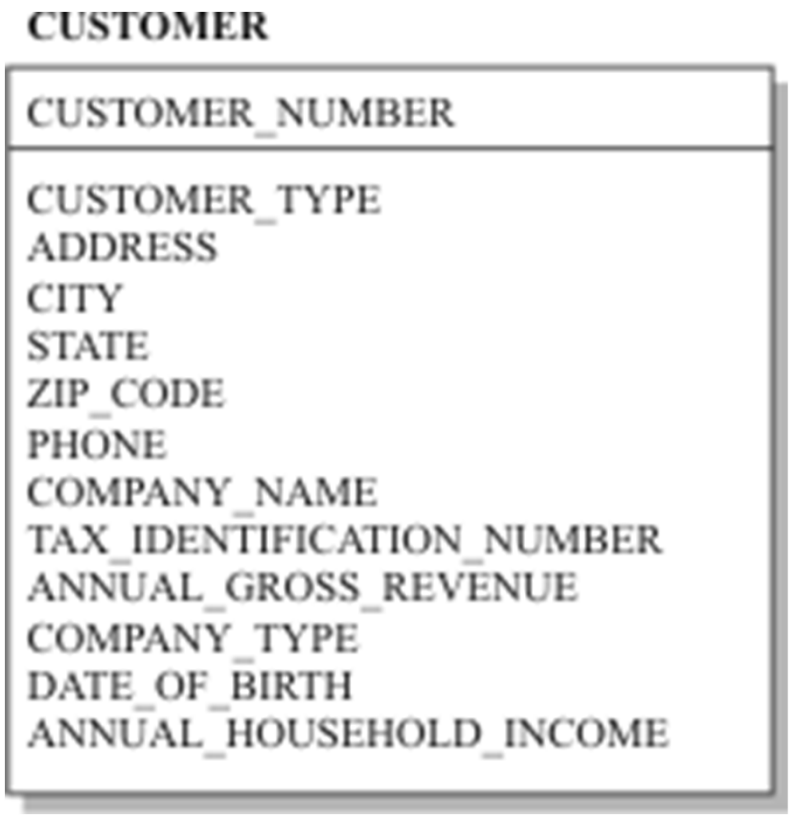


Table Naming Conventions

- Table names based on entity names
- Table names unique across entire organization
- Consistency of singular vs. plural names
- Do not use names like “table” or “file”
- Best to use only uppercase letters and underscores
- Best to use abbreviations only when necessary
- Avoid limiting words such as WEST_SALES

Column Naming Conventions

- Column names based on attribute names
- Column names unique within the table
- Best to use only uppercase letters and underscores
- Prefixing column names with entity names is controversial
- Best to use abbreviations only when necessary
- Foreign key column names same as primary key columns except when role names are required

Constraint Naming Convention

- Important because constraint names can appear in DBMS error messages
- Suggested convention: TNAME_TYPE_CNAME where:
  - TNAME is the name of the table
  - TYPE is:
    - PK for primary key constraints
    - FK for foreign key constraints
    - UQ for unique constraints
    - CK for check constraints
  - CNAME is the most important column name

Index Naming Convention

- Most DBMSs permit indexes for primary key / unique constraints to be pre-defined, so you can specify name
- Suggested convention: TNAME_TYPE_CNAME where:
  - TNAME is the name of the table being indexed
  - TYPE is the type of index:
    - UX for unique indexes
    - IX for non-unique indexes
  - CNAME is the name of the most important column

View Naming Conventions

- Must be unique among all tables, views and synonyms in the same schema
- Suggested convention:
  - End names with a suffix such as _VW
  - Include the name of the most table
  - Attempt to describe the purpose or contents of the view
  - Add any abbreviations used to the standard list

Implement Business Rules as Constraints

- NOT NULL constraints
- Primary key constraints
- Referential (foreign key) constraints
- Unique constraints
- Check constraints
- Data types, length, precision/scale
- Triggers

Adding Indexes for Performance

- How a b-tree (balanced tree) index works:
  http://mattfleming.com/node/192

- How a bit map index works

Index Guidelines

- Remember that RDBMSs automatically create indexes for primary key and unique constraints
- Indexes on foreign key columns can dramatically improve join performance
- If a query selects only columns from a single index, table row fetches are not necessary
- Consider indexes on columns that are frequently referenced in WHERE clauses
- Indexes on long VARCHAR columns are seldom useful
- Indexes cannot be used to find NULL values

Index Guidelines (2)

- The larger the table, the less you want table scans
- Indexes on frequently updated columns can be trouble
- For relatively small tables, table scans are just fine
- For tables with short rows that are most often accessed using primary keys, consider an index organized table
- Consider the performance consequences before defining more than two or three indexes on a table
- For B-tree, index selectivity needs to be high (0.8 – 1.0)
- For low selectivity and relatively few values, consider a bitmap index

Designing Views

- View Restrictions:
  - For views referencing multiple tables, any insert, update or delete can only reference columns from one table
  - Inserts are impossible when required (NOT NULL) columns are left out unless they have DEFAULT values
  - Calculated and derived columns in views cannot be updated
  - View access requires privileges (just as table access does)
  - DBMSs vary somewhat in view support and restrictions

Advantages of Views

- In some RDBMSs, view access performs better than table access (stored procedures may be better still)
- Views may be tailored to user department needs
- Views can provide alternative representations (transformations) of the data
- Views insulate users from some table/column changes
- Views simplify access by hiding complex joins and calculations
- Views can omit rows and columns that users don't need to see (a good security tool)
- Views can reestablish supertypes and subtypes that were no implemented