Datawarehousing for OLTP Data Modelers

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Overview

- Transactional systems vs Data Marts/Warehouses
  - OLTP vs OLAP – transactional vs. analytical processing
  - Technology and Methodology
    - What skills must be are common to both
    - What skills must be “unlearned”?
    - What skills are new?

Overview

- Topics:
  - Database Design
    - Logical Design
    - Physical Design
  - Updating and Reporting on Database Contents
  - Methodology
    - Project Team
    - Development Life Cycle
    - Tools: build or buy?

Database Design

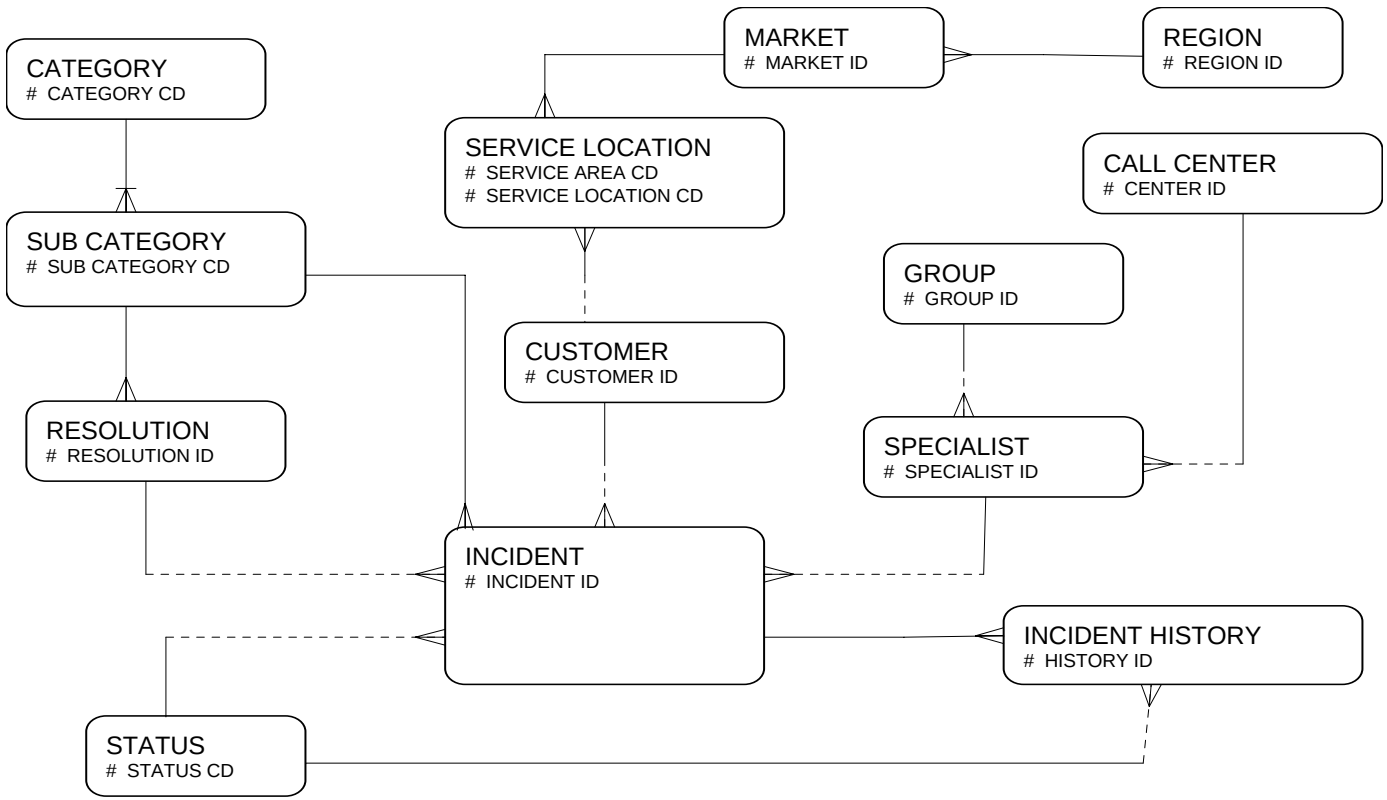
- Sample OLTP design
- Sample Data Mart design for the same data
- Differences in methodology

Logical DB Design

- Sample - Customer Care System
  - Many accounts, each in a marketing hierarchy (region, market, service area)
  - Each account may generate numerous trouble calls (incidents)
    - Each incident is assigned to a specialist at a call center
    - Each incident may take many calls to resolve
    - Each incident is categorized as to its type and resolution

Logical DB Design

- Customer Care - ERD



Logical DB Design

- Customer Care - ERD
  - Lots of one-to-many relationships (hierarchies; master-detail)
  - Lots of many-to-one relationships (descriptions; codes)
  - Normalized (3NF) design

OLTP Design Methodology

- Requirements Analysis
  - Determine the data required in the system and the relationships between entities
  - Determine process/functional requirements with user sign-off - a formal Functional Requirements List
- Agile/Extreme Methods
  - How much ahead-of-time analysis is appropriate?

OLTP Design Methodology

- Normalization
  - "A column in a table is a fact about the key, the whole key, and nothing but the key, so help me Codd."
  - Normalization eliminates "update anomalies"
  - The trade-off is that many tables must be joined to retrieve all relevant information

Data Mart Design Methodology

- Requirements Analysis - OLAP
  - How much analysis is required/desirable, given that the system's goal is "adhoc" inquiries and/or to support data mining?
  - Tierstein Analysis: What are the top 10 questions you need to be able to answer?
  - Data Mining: What are the "groupings" that you will be interested in?

Data Mart DB Design

- Performance/Functional Requirements
  - Data is static, so updates are not required
  - Retrieval speed is paramount
  - Capacity planning/scalability is critical
  - Database refresh must fit in maintenance window

Data Mart DB Design

- Star Schema
  - Find the central “fact” that the user is interested in:
    - OLTP Hint: Follow the master-detail relationships down to the appropriate level of detail; that’s probably your fact
    - OLTP Hint: Think “transaction” -- sale, history, scheduling

Data Mart DB Design

- Star Schema
  - The descriptive codes describing the fact are "dimensions"
    - OLTP Hint: The date is almost always a dimension.
    - OLTP Hint: The OLTP reference (code) tables of the fact are also one dimension, with different levels of detail "denormalized" into one table
  - What is a "small" dimension?

Data Mart DB Design

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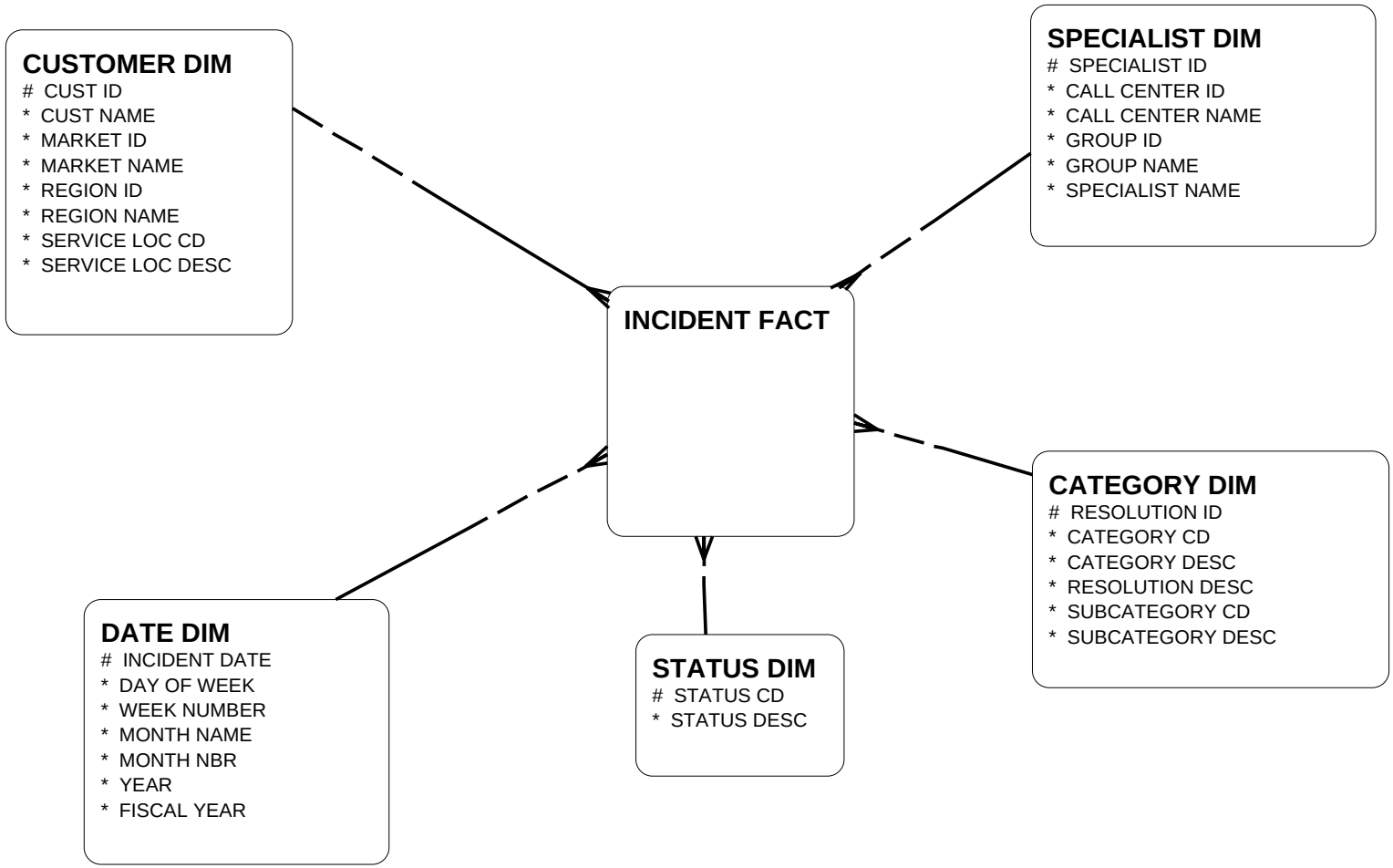
- Star Schema
  - An ERD ends up with a central fact, and dimensions radiating out from it - a star
  - A data mart (or data warehouse) can consist of one or more stars
  - The stars can (should) share dimensions

Data Mart Star Schema



Data Mart DB Design

- Snowflake
  - Sometimes, a dimension in a star schema will, itself, have dimensions
  - This results in a snowflake configuration
  - Snowflakes may have performance issues
  - Some BI tools perform better with different DB designs: Normalized, star, snowflake

Data Mart DB Design

- Fact and Dimension Tables
  - Attributes: Alphanumeric descriptive data
    - Derived attribute: age range, salary range, call length
  - Metrics: Numeric data about the fact
    - “Factless fact” – fact table with no metrics
    - OLTP hint: An intersection table with no additional attributes
  - Sparsity vs. denseness of data

Physical Design Issues

- Natural vs. Artificial Primary Keys
- Denormalization
- Summarization
- Server-Side Referential Integrity Constraints
- Database Partitioning
- Application Tuning, including Indexes

Physical Design

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Assumption: Relational implementation, not a multi-dimensional cube

Natural vs. Artificial Keys

- Natural Primary Key - Value is intelligible to the user, and occurs naturally in the application
- Artificial Primary Key - Value is artificially derived, eg, from an Oracle sequence

OLTP Primary Keys

- Can be a religious argument
- Use artificial keys if:
  - The natural key value is subject to change
  - The key structure is too complex (> 5 columns, 64 characters)
  - Part of the natural key may be null
  - To reduce code lookups
  - Your project standards say to

Data Mart Primary Keys

- Always use artificial keys:
  - The natural key value might not be unique (for example, when collecting data from multiple systems)
  - Indicated for use with bitmap indexes
  - Supports “slowly changing dimensions”, when the natural key value is the same but its semantics change

Slowly Changing Dimensions

- What if a dimension changes:
  - Example: Market A used to be in the Western region, now it's in a new, Mountain region
- How can we compare summaries by region from before and after the change?
- Approaches:
  - 1: Lose the history and realign (or not) data
  - 2: Add new dimension records for new data
- Several different implementations

Referential Integrity

- OLTP Referential Integrity
  - Server-side declarative constraints
  - Server-side procedural code
  - Client-side GUI controls

Referential Integrity

- Data Mart Referential Integrity
  - Are server-side RI constraints needed?
    - All updates are done via one load program
    - Load program should reject dirty data -- and report on it
  - RI constraints should be disabled when loading data
    - Ability to use direct path load
  - RI constraints may be required by BI tools

OLTP Denormalization

- Methodology whereby a normalized design is “broken”, typically to enhance performance
  - Store summary of detailed data in the master table (to decrease accesses)
  - Store derivable data in the table (to enable indexed searches)

Data Mart Summarization

- Determine the level of detail of data to be stored
- Redundantly store derivable (summary) data, typically to enhance performance
- Use materialized views if
  - You can predict your most frequent queries
  - You have sufficient disk space (for views and view logs)
  - You have time to refresh the views

Data Mart Summarization

- Summarization/Aggregation - Approaches
  - Store individual “transactions”
  - Summarize transactions on load
  - Summarize transactions after a period of time

Data Mart Summarization

- Summarization
  - Maintain summary table(s) (materialized views) which summarize the facts by the most frequently combined dimensions
    - Example: Incident by Resolution by Region
  - Summary tables must be refreshed whenever the database is refreshed
    - Refresh “on demand” as part of the load process

Database Partitioning

- Dividing tables and indexes into partitions
  - Read performance – “partition pruning”
  - Write performance – ability to drop a partition, rather than delete rows
  - Admin performance – ability to assign different partitions to different tablespaces (for backup)
- Must be designed into the ETL process

Application / Database Tuning

- These disciplines differ greatly between OLTP and Data Mart database
- Examples:
  - Estimating table size (extents; volatility)
  - Indexes (bit maps vs. b-tree searches)
  - In OLAP, a Full Table Scan (FTS) may be good

Refreshing Database Contents

- OLTP
  - Convert data from legacy system(s)
  - One-time task
- Data Mart
  - Initially load the data mart from source system(s)
  - Refresh database contents at regular intervals

OLTP Data Conversion

- Methodology and Technology
  - Too often, “seat of the pants”
  - Tools are expensive for one-time use
  - Legacy system experts may be hard to find
- “One-time” use
  - But may have to reload data
  - Phased cutovers

Data Mart Refresh

- Methodology and Technology
  - E(T)TL tool is required:
    - Extract source data
    - (Transport data to new platform)
    - Transform data to new format
    - Load data into new database
- Tools
  - Oracle Warehouse Builder
  - Informatica
  - Tools with domain-specific “adapters”

Data Mart Refresh

- ETL tool
  - Maintain metadata about source system(s) - still in use and being maintained
  - Maintain metadata about data mart - should be user accessible
  - Maintain history of refresh cycles

Data Mart Refresh

- ETL Tool/Code
  - Periodically add new data to the data mart
  - Modes of operation
    - Batch/File-based: Must be run in the “maintenance window” for the source and target systems
    - Near real-time: Message queues

Data Mart Refresh

- Operational Data Store (ODS)
  - Normalized database which acts as the feeder system to the data mart
  - Extract data from source system(s) into ODS
  - Load from ODS using refresh routines

Data Mart Refresh

- Design Issues
  - Change Data Propagation - How do you know which source records are new and need to be loaded?
  - Are records ever purged from the data mart? Summarized?
  - Are records ever updated in the data mart?

Conclusions (1)

- Logical Design
  - Replace 3NF databases with stars and snowflakes
  - A normalized database may be used for an ODS
  - “Requirements” may not be as formal

Conclusions (2)

- Physical Design
  - Know how to denormalize and summarize (ie, “enhance” the underlying model for performance)
  - Pay more attention to tuning (the data mart is born large)

Conclusions (3)

- Data Mart Refresh
  - Formalized methodology and technology required
  - Metadata is an issue
  - Performance (load time)
    - Change data propagation
    - Materialized views and view logs
    - Partitioning
    - Parallel object creation
    - Direct path loads and inserts

Conclusions (4)

- Reporting
  - BI tool required for end-user adhoc report creation
  - Data mining
  - Performance (reporting)
    - Materialized views for aggregates/summaries
    - Partitions
    - Bitmap indexes

About the Author

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