
CSI:
CRIME SCENE INVESTIGATION™
DATA WAREHOUSE

Anatomy of a VLDW

CSI:DW
Anatomy of a VLDW

Dave Fackler
Business Intelligence Architect
davef@rollinghillsky.com
@sqlbiguru
http://linkedin.com/in/davefackler

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Agenda

- The Crime Scene
  - VA's DW and BI Landscape
  - DW Model and Metadata Infrastructure
- The Evidence
  - Database Infrastructure and Table Versioning
  - ETL and Data Distribution Architecture
  - Data Mart and Project Infrastructure
  - OLAP and Reporting Architecture
- Who Done it?
  - The Teams Behind it All

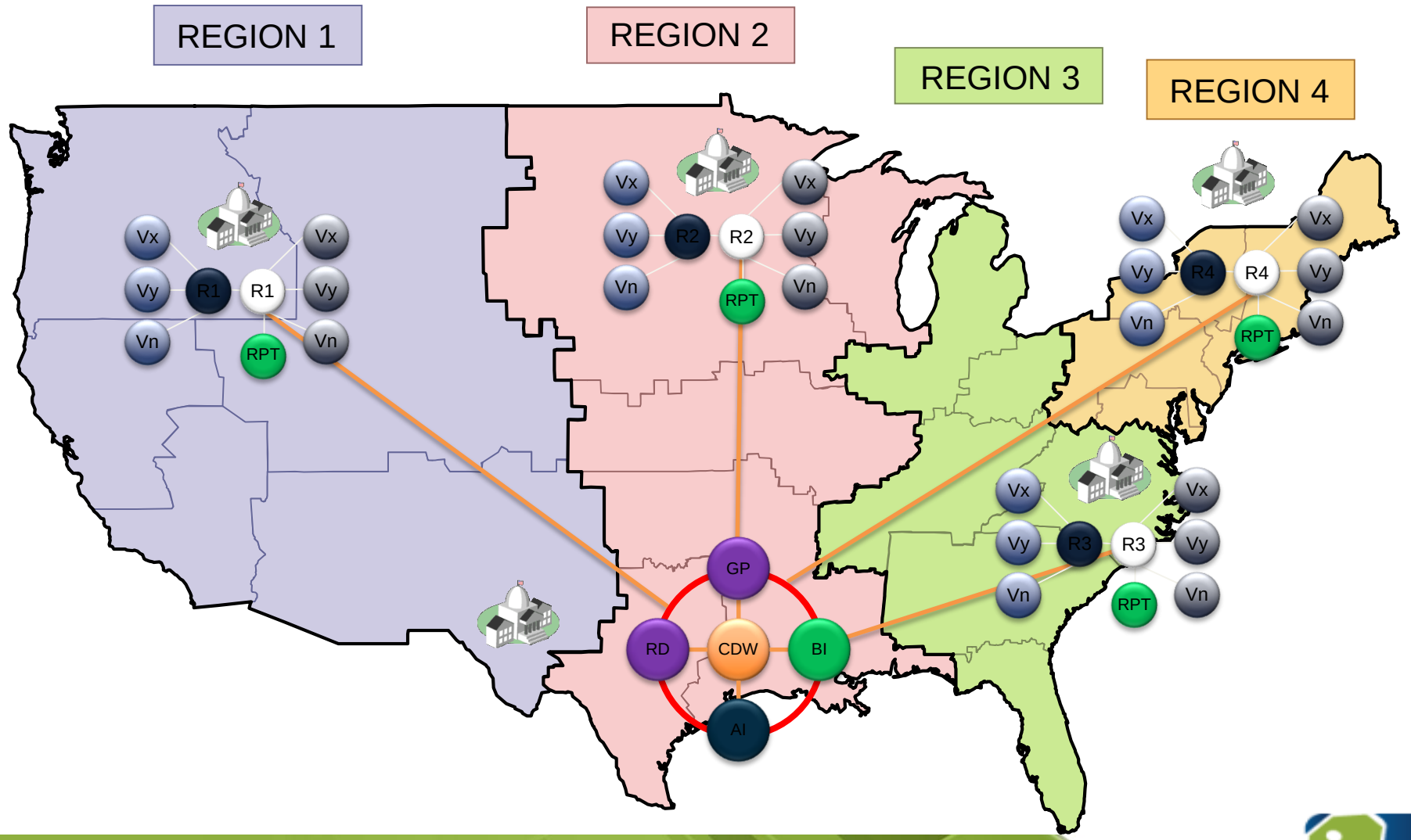
The Crime Scene

VA's DW and BI Landscape

- VA organized into VISN's
  - VISN = Veteran Integrated Systems Network (21 total)
  - Geographically close medical centers and clinics
- Each VISN manages 1 or more VistA systems
  - VistA = Electronic Health Record system for VHA
    - Clinical functions, financial functions, administrative functions, etc.
    - Basically, ***THE*** OLTP system for the VHA
  - Each VistA system is independent of others (130 total)
    - Can exchange data, staff can view data from multiple systems
  - VistA based on MUMPS and Intersystems Caché

VA's DW and BI Landscape

- Data Warehouse environment
  - Uses a "tiered" architecture
    - Corporate Data Warehouse (CDW) includes all national data (3+)
    - Regional Data Warehouse (RDW) includes regional data (4)
    - VISN Data Warehouse (VDW) includes VISN data (21)
    - Users connect to environment with scope of data they need
  - Same data model, same surrogate keys, same data
- BI (reporting) environment
  - Lots of tools (SSRS, Excel/PowerPivot, Pyramid Analytics)
  - Lots of teams developing data marts, cubes, reports
  - Wide range of what we call "projects" based on the DW


REGION 1
REGION 2
REGION 3
REGION 4
Vx
Vy
Vn
R1
R2
R3
R4
RPT
GP
RD
CDW
BI
AI


CRIME SCENE DO NOT CROSS

VA's DW and BI Landscape

- Explosive growth since 2009
  - Overall data volumes have surpassed a trillion rows
  - Over 4,700+ users authorized for CDW/RDW access
  - Over 30,000 users authorized for VDW access
- But continuing to grow (and grow and grow)
  - Continuously adding more data domains
  - Scaling up and out
  - Adding more users every month
  - Supporting more reporting solutions daily

Data Warehouse Model

- Star/snowflake schema
  - Dimension tables (274 dimension tables and growing)
  - Fact tables (25 domains, 175 fact tables and growing)
  - Every table has surrogate key (even fact tables)
  - Every table has consistent ETL auditing columns
  - Every table has business keys with standard names
  - Every table follows standards for naming, data types, etc.
- All users access data view two sets of views
  - First set filters out deleted records (all deletes are “soft”)
  - Second set includes deleted records

Metadata Infrastructure

- Data modeling team manages metadata database
  - Includes all table/view information
    - Published from ER/Studio via custom code and scripts
  - Also includes “mapping” information from VistA
    - VistA data model catalog imported via ETL process
    - So, data modeling team has that data available
- Metadata information made available to users
  - As report using SSRS
    - Shows metadata for tables/views plus mapping information
    - Also shows E/R diagrams published from ER/Studio
  - As data via views in the DW data model

The Evidence

Database Infrastructure

- Data model split into multiple databases
  - One database for dimension tables
  - Several databases for fact tables
    - Mostly based on legacy database management decisions
  - Databases consistent in CDW and RDW environments
  - In VDW environments, a single database is used
- All user access views kept in two databases
  - One filters deleted records, the other does not
  - Views use three-part names and database chaining

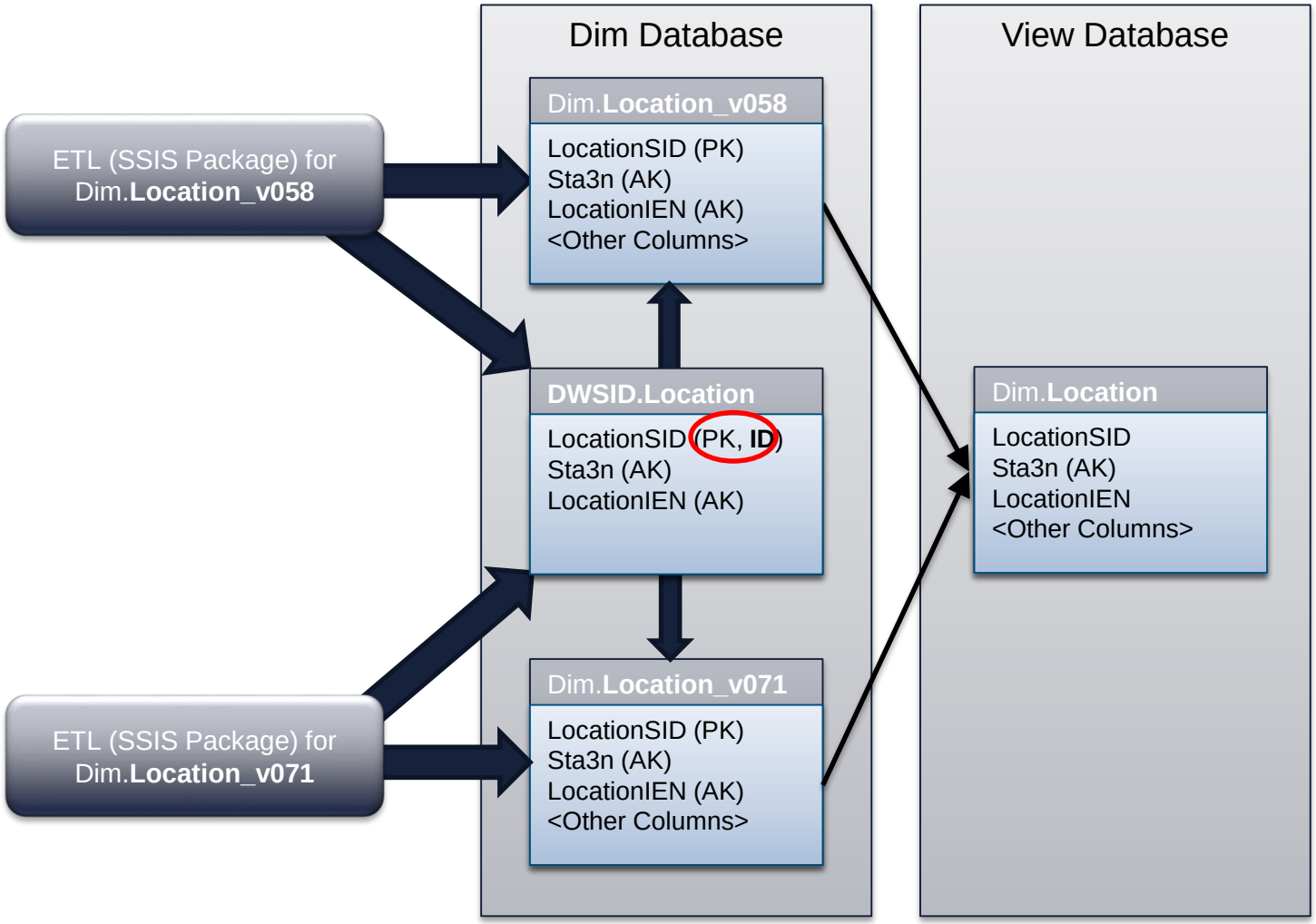
Table Versioning

- Schema changes were hard to make early on
  - How do you manage adding a new column to a table with 2B rows? Particularly across 28+ environments?
  - How can you make schema changes when users will not accept table “down time”? Reports must run!!
- Decided on table versioning strategy
  - Every table is named with a version number at the end
  - User access views drop version numbers from names
  - Schema changes become new versions
  - User access views can then be changed when ready

Table Versioning

- Surrogate keys assigned using special table
  - Surrogate key implemented as identity() column
  - Table has business keys but nothing else
- Versioned tables get surrogate keys from there
  - Ensures business keys assigned the same surrogate key
  - Allows for moving from one version to the next
- As new table version is adopted, old one dropped
- System developed for orchestrating table development and deployment

Table Versioning



ETL Process

- Data pulled from VistA systems on a NRT basis
  - Data landed in a special set of tables (FDW)
  - Data is not modeled except in special circumstances
  - Deletes in VistA are marked as “soft” deletes
- ETL process then updates RDW environments
  - Runs on a nightly basis
  - Uses incremental extracts from FDW, loads into RDW
- Data Distribution System then updates CDW, VDW
  - Batches of data loaded into RDW are BCP’d to flat files
  - Files are then copied and loaded on other systems

ETL Process (Step 1)

- VistA systems use “journaling” for disaster recovery
  - Allow for “mirrors” of production systems, typically kept up-to-date with 5-30 seconds latency (asynchronous)
  - DW team leverages this and “mirrors” all 130 systems
- DW team developed “Journal Reader” application
  - Monitors journals going to mirrors looking for transactions
  - If transaction involves data entity we care about (based on metadata information), copies transaction to SQL Server
  - Feeds data into Feeder Data Warehouse (FDW) tables
  - Very simple transformations (dates, for example)

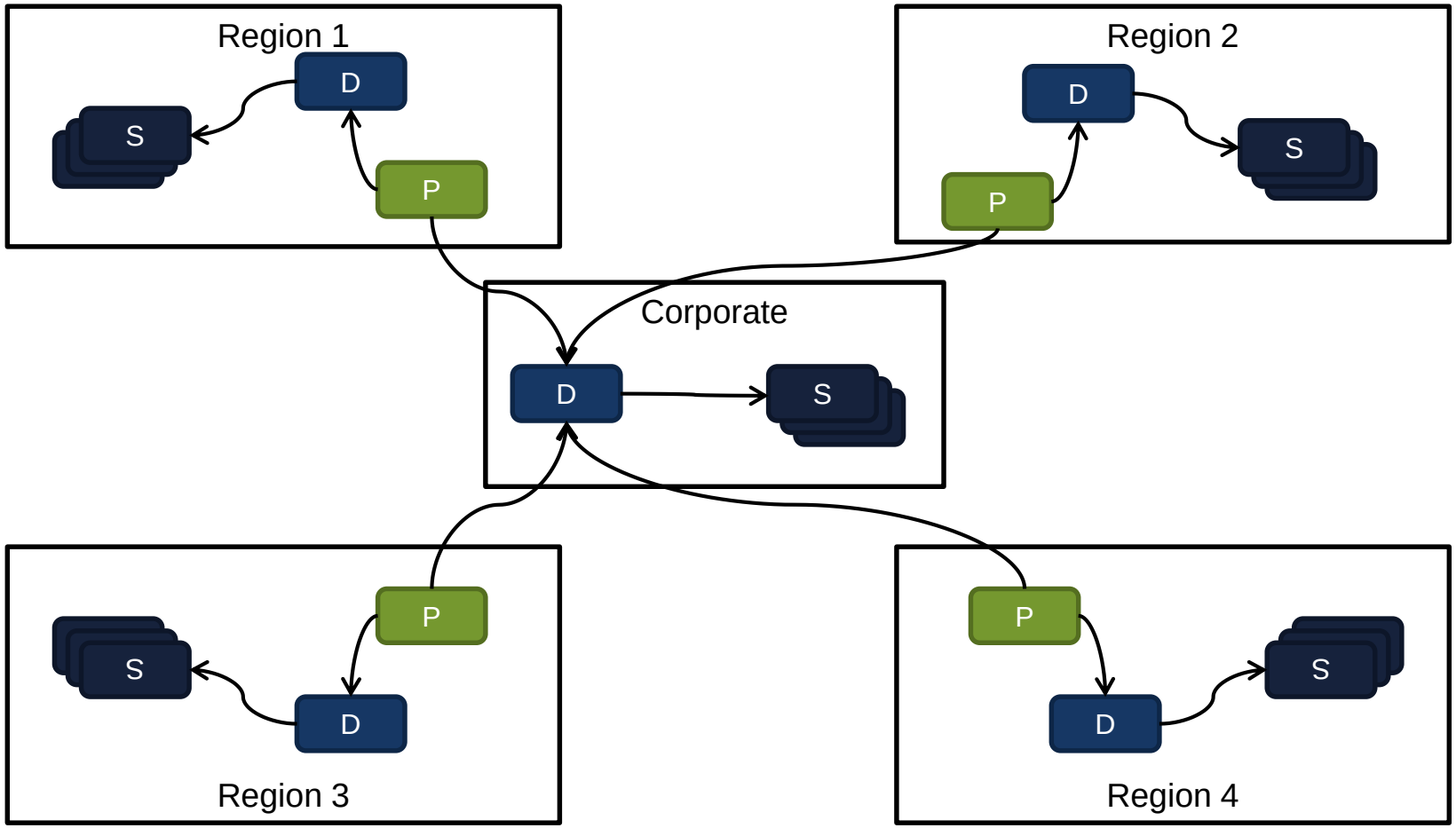
ETL Process (Step 2)

- ETL process then runs nightly
  - SSIS packages
    - One per versioned table
    - Master package dynamically orchestrates others (metadata)
  - Each package
    - Uses standard auditing logic and auditing table structures
    - Incrementally extracts from FDW table
    - Determines inserts versus updates
    - For smaller tables (10M and lower), just uses MERGE
    - For larger tables, uses INSERT (fast load) and UPDATE
    - Uses inferred member logic as needed
    - Uses special surrogate key tables for surrogate key generation

Data Distribution System

- Developed to handle loading CDW and VDW
  - Initially used linked servers back to RDW environments
    - CDW environments connected to each RDW environment
    - VDW environments connected to local RDW environment
  - Loading via MERGE commands via linked servers
    - Did not like linked server dependencies
    - Hard to troubleshoot and reload something
- DDS uses publisher/distributor/subscriber model
  - RDW environments “publish” flat-files of batches of data
  - Distributors move flat files from data center to data center
  - Subscribers load data from flat files

Data Distribution System



Data Mart and Project Infrastructure

- Lots of different teams want to report off DW data
  - Often too much data for what they want
  - Sometimes not structured how they want
  - Classic data warehouse versus data mart scenario
- Implemented “project” model and infrastructure
  - Teams now request “projects” which can include
    - SQL database(s), ETL server access and proxy
    - SSAS databases(s)
    - SharePoint (SSRS) site, reporting account
    - TFS support
  - Now supporting over 500 different projects

OLAP and Reporting Infrastructure

- Moving toward SSAS “farms” for projects
  - Processing servers and query servers
  - Developing “sync” framework and application now
- SharePoint with SSRS in integrated mode
  - Several different SharePoint farms for different groups
  - SSRS used for a lot of projects and a lot of reports
  - SSRS usage logs consolidated and made available
- Pyramid Analytics
  - Newest reporting tool implemented to replace ProClarity
  - Seeing very quick adoption (8,000+ users after 6 months)

Who Done It?

The Teams Behind it All

- Business Intelligence Service Line
  - Created to manage DW/BI infrastructure, solution, tools
  - Manager servers, data flow, “projects” workflow, etc.
  - Divided into “core” teams and “regional reporting” teams
- Core Teams
  - Architect Team (data modelers) 5
  - DBA Team (manage all aspects of DB servers) 7
  - VistA Extract Team (develop/manage extracts) 4
  - ETL Team (develop/manage all ETL procedures) 7
  - SSAS Team (manage SSAS infrastructure) 3

The Teams Behind it All

- Regional reporting teams
  - Four teams, one for each VA region
  - Develop solutions focused on healthcare operations
    - Morning reports, hospital operations, pharmacy costs, etc.
  - Partner with various business groups at various levels throughout their regions
  - Each team has 6-10 resources
- Ancillary resources
  - Training coordinator, technical writer, geospatial team
  - SA Team (responsible for hardware, OS of all servers)

Questions?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