Near Real-Time Data Integration

Active Data Warehouse Workshop
Continuous TPump in a W2K/WinXP Environment

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Outline

► Active Warehouse
► Continuous Data Integration
► Need for Messaging Infrastructure
► TPump in a Continuous Environment
► Message Queuing Infrastructure
  – Setting up MSMQ
    • MSMQ 2.0 (W2K)
    • MSMQ 3.0 (WinXP)
  – Setting up TPump & database
  – Setting up QTool

► QTool
  – Queue Administration
  – Data Feeding
  – TPump Job-Scheduling

► Results & Comparison
  – ADW CoE Sample, QTool
  – MSMQ, MQSeries

► Conclusion
Traditional Data Warehousing

- Collection of data to support management needs (complex analysis for strategic decisions) [Inmon 1992]:
  - subject-oriented
  - integrated
  - time-variant
  - nonvolatile
- High volumes of data
- Integration of external data
- Batch load ("update window")

Examples of data warehouse usage:
- Analyze product sales, stock inventory, customer behavior, etc.
- Analyze process performance, etc.

Information Evolution in a traditional Data Warehouse Environment

Stage 1: REPORTING
WHAT happened?

OBSERVE:
Mainly batch with pre-defined queries

Stage 2: ANALYSIS
WHY did it happen?

UNDERSTAND:
Increase in ad-hoc queries

Stage 3: PREDICTION
WHAT will happen?

PREDICT:
Increase in analytical model construction

Batch reporting
Ad-hoc reporting, On-line analytical processing
Analytics, Data mining
Near Real-Time Data Integration

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Information Evolution in an Advanced Data Warehouse Environment

Stage 4: OPERATIONAL DATA WAREHOUSE
WHAT is happening?

Stage 5: ACTIVE WAREHOUSE
What do I WANT to happen?

Stage 6: MINIMIZED LATENCY
What's the FEEDBACK?

REACT:
Continuous updates and time sensitive queries gain importance

RE-ORGANIZE:
Event-based triggering

AUTOMATE & CONTROL:
Closed loop on information integration and automated information delivery

Batch reporting
Ad-hoc reporting, OLAP
Analytics, data mining
Continuous update, tactical queries
Event-based triggering, automated reactions
Notifications

What is an Active Data Warehouse?

Traditional Data Warehousing
– Focus on “ivory tower” decision makers
– Long-term decision making
– Strategic focus

Active Data Warehousing
– Expand scope to include “in the field” decision makers
– Day-to-day (minute-to-minute) decision making
– Tactical focus with strategic implications

Business needs both strategic and tactical decision support capabilities.
What is an Active Data Warehouse?

<table>
<thead>
<tr>
<th>Traditional</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic decisions only</td>
<td>Strategic + tactical decisions</td>
</tr>
<tr>
<td>Results sometimes hard to measure</td>
<td>Results measured with operations</td>
</tr>
<tr>
<td>Daily, weekly, monthly data</td>
<td>Only comprehensive detail data</td>
</tr>
<tr>
<td>currency acceptable; summaries</td>
<td>available within minutes is</td>
</tr>
<tr>
<td>often appropriate</td>
<td>acceptable</td>
</tr>
<tr>
<td>Limited number of users accessing</td>
<td>High number (1000+) users</td>
</tr>
<tr>
<td>the system concurrently</td>
<td>accessing and querying the</td>
</tr>
<tr>
<td></td>
<td>system at the same time</td>
</tr>
<tr>
<td>Highly restrictive reporting used to</td>
<td>Flexible, ad hoc reporting as well</td>
</tr>
<tr>
<td>confirm/check existing processes and</td>
<td>as machine assisted modeling</td>
</tr>
<tr>
<td>patterns. Often using pre-built</td>
<td>such as data mining to discover</td>
</tr>
<tr>
<td>summary tables or data marts.</td>
<td>new hypotheses</td>
</tr>
<tr>
<td>Power users, knowledge workers,</td>
<td>Operational staffs, call centers,</td>
</tr>
<tr>
<td>internal users</td>
<td>external users</td>
</tr>
</tbody>
</table>

Business Drivers for Minimized Latency

- **Decrease the time** it takes to make the business decisions.
- **Minimize latency** between the **cause and effect** of a business decision.
- **Notify** the business of actionable **recommendations**.
- **Effectively close the gap** between business intelligence systems and business processes.

**Analytical decisions integrated into operational processes combined with closed loop analytics.**
Important requirement for Teradata Active Data Warehouse:  
Ability to provide data that is close to up-to-date

Teradata Options:

FastLoad
- Short, frequent FastLoad executions
- Loading data into an empty table for later select/insert/update processing into the final target table

You cannot use the FastLoad utility to:
- Insert additional data rows into existing tables
- Update individual rows of existing tables
- Delete individual rows from existing tables
- Load data into multiple tables

MultiLoad
- Frequent MultiLoad executions directly into target table
- Issues: Efficiency, concurrency, resource consumption

TPump
- Data feed from message queues in a continuously executing mode:
  - Message queuing infrastructure
  - Feeding tool
  - Scheduler for continuously executing TPump jobs
**Why TPump?**

- **Economies of scales**
  - MultiLoad is not necessarily efficient when operating on large tables (fact table) when there are not many rows to insert or update.
  - For MultiLoad to be efficient, it must touch more than one row per data block in the Teradata database.

- **Concurrency**
  - No limit for TPump instances running concurrently (MultiLoad: 15 instances).
  - TPump uses row-hash locks, making concurrent updates on the same table possible (MultiLoad: table-level locks).

- **Resource consumption**
  - TPump allows the operator to modify the statement rate, while the job continuously runs.
  - MultiLoad is designed for the highest possible throughput, and uses any available database and host resources.

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**Motivations using TPump for NRT Data Integration**

- TPump is suitable, when some of the data needs to be updated closer to the time the event or the transaction took place
- avoids table-level locks (row-hash locks only)
- flexibility in when and how it is executed
- queries can access a table concurrently with TPump
- several TPump jobs can run against the same table at the same time
- sources as varied as MVS, NT or UNIX concurrently
TPump as Continuous ETL Tool?

Limitations:

- Concatenation of data files is not supported. File size limit: 2 GB.
  → We will solve these by using message queues!

- Data retrieval capability from the Teradata RDBMS via SELECT statements is not allowed.
- Arithmetic functions are not supported.
- Access Logging can cause a severe performance penalty in TPump, because TPump uses normal SQL operations.

Need for a Messaging Infrastructure

Continuous data integration

→ message-level Enterprise Application Integration (EAI):

- Asynchronous, connectionless service
  (vs. RPC or socket-based communication)
- Reliable delivery, transaction support if required
- Priority-based messaging
- Decoupling from transactional systems
  → supporting dynamic data rates
  → source systems: information push
  → data integration: information pull

- Common options: IBM MQSeries®, Microsoft MQ (MSMQ)
Rotating TPump Architecture

Continuous Data Integration based on Teradata:

Source Feeds → Messag. Server → Load Server → RDBMS

- **Source Feeder:**
  - Read input
  - Assign priority
  - Write messages

- **Message-level EAI (MSMQ):**
  - MQGet
  - MQPut

- **Scheduler:**
  - Starts load and cleanup jobs
  - Forces EOJ (EOF) to queue
  - Initiates post-job processing

- **Load Job(s):**
  - SQL: Insert, Upsert, Update

- **Messag. Server:**
  - MQ Access Module
  - Buffers
  - NOTIFY exit

- **Load Server:**
  - EOJ

- **Input Data:**
  - MQAccess
  - Module

Role of Source Feeder

- **Provide application data feeds:**
- **Read transaction messages from a file**
- **Add a timestamp to the message**
- **Put message into the queue**
- **Arrival rate is adjustable**

- **Discussion: state vs. event data**
Role of Messaging Infrastructure

- Provide low-latency data feeds:
  - Multiple sources can feed the queue
  - Reliable delivery, transaction support if required

- Asynchronous delivery:
  - Source systems can write in (near) real-time
  - Load utility may process the message immediately or some time later

- In general: FIFO (first-in-first-out) processing of messages

Role of Access Modules

- Connect to MSMQ / MQSeries:
  - Local or remote connection
  - Get messages from MSMQ / MQSeries
  - Add timestamp to the messages
  - Stream messages to TPump

- Guaranteed reliability:
  - No lost inserts
  - No duplicate inserts
Role of Scheduler

- Coordinate two parallel TPump instances:
- Start TPump job
- End TPump job by placing an EOF message to the Queue
- Launch post-job processing: BTEQ script to consolidate error rows inside Teradata.
- Monitor load process status/results.

Scheduling:

- TPump1 initializes, starts up and reads from the queue
- TPump2 initializes & waits
- TPump2 ends, sets off BTEQ script
- TPump2 starts up and reads from queue
- TPump1 starts up and reads from queue
- BTEQ1
- BTEQ2

QTool / TPump Job-Scheduling
Advantages of „rotating“ TPump instances

- Quicker confirmation of success or failure of a particular load portion.
- Quicker access and reprocessing of error tables.
- Job validation & performance analysis based on end-of-job statistics (e.g. audit trail).
- Opportunity to change parameters on subsequent iterations of TPump (in order to react on changes in the environment).

Role of TPump

- Provide flexibility in continuous data loading:
  - TPump is suitable, when some of the data needs to be updated closer to the time the event or the transaction took place
  - avoids table-level locks (row-hash locks only)
  - queries can access a table concurrently with TPump
  - several TPump jobs can run against the same table at the same time
  - flexibility in when and how it is executed
Outline

- Active Warehouse
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- Need for Messaging Infrastructure
- TPump in a Continuous Environment

Message Queuing Infrastructure
- Setting up MSMQ
  - MSMQ 2.0 (W2K)
  - MSMQ 3.0 (WinXP)
- Setting up TPump & database
- Setting up QTool

QTool
- Queue Administration
- Data Feeding
- TPump Job-Scheduling

Results & Comparison
- ADW CoE Sample, QTool
- MSMQ, MQSeries

Conclusion

MSMQ Features

- Integrated with
  - WinNT4: MSMQ 1.0
  - Win2K: MSMQ 2.0
  - WinXP: MSMQ 3.0
- Security, message persistence, transaction support

- Public Queues published through directory service
  - Win NT 4 / MSMQ 1.0: SQL Server 6.5
  - Win2K / MSMQ 2.0: Active Directory at domain controller
  - WinXP: Public queues without directory service possible

- Private Queues are not published
  - no directory service overhead

- More Details: http://www.microsoft.com/msmq
# MSMQ 2.0

- Win2K Professional, Win2K Servers
- Win2K security integration (Kerberos)
- Encryption: 40 bit, 128 bit
- Active Directory integration  
  (Workgroup mode is possible but tricky to setup)
- Windows Cluster (active/active) support
- 2GB storage limit per machine
- MSMQ - MQSeries bridge is available
- Cross plattform support:  
  MQC (Message Queuing Connectors) for Unix, CICS/MVS,  
  VMS, AS/400

## MSMQ 2.0 Setup

- **Recommended:**  
  Re-install MS DTC (Distributed Transaction Controller)  
  → run: \winnt\system32\dtcsetup.exe

- **Install MSMQ 2.0 (Win2K)**  
  → Settings  
  → Control Panel  
  → Add/Remove Programs  
  → Add/Remove Windows Components  
  → Install Message Queuing Services

- **Create message queues using the management console snap-in**  
  (run: compmgmt.msc /s)
MSMQ 2.0 Workgroup Mode

- Optional: Configure MSMQ for Workgroup Mode

Workgroup Mode:
- Running MSMQ on Win2K within a Windows domain but not on the domain controller
- Enables only private queues on the local machine
- No directory service overhead

MSMQ 2.0 Workgroup Mode Setup

Enable Workgroup Mode:
- Modify Win2K registry:
  - HKLM \ Software \ Microsoft \ MSMQ \ Parameters \ setup
  - Add DWord "AlwaysWithoutDS" = 1
- Restart Win2K
**MSMQ 2.0 Management**

Management Console Snap-In, run: `compmgmt.msc /s`

![Management Console Snap-In](image)

**MSMQ 2.0 Troubleshooting**

- Event ID 2124: Message Queuing was unable to join the local Windows 2000 domain.
- Event ID 2121: Unable to complete Message Queuing Setup.
- Hresult: c00e0075h

→ Re-install MS DTC
→ Configure MSMQ in Workgroup Mode
Near Real-Time Data Integration

MSMQ 3.0

- WinXP Professional (available)
- WinXP Servers (current state: RC1)

- New Features
  - Messaging based on HTTP / HTTPS
  - SOAP extensions for reliable messaging (based on HTTP)
  - Network load balancing / web-farm support
  - Multicast messaging
  - Message trigger concept (based on ECA rules)

- 1TB storage limit per machine
- Easier administration & deployment

MSMQ 3.0 Setup

- Install MSMQ 3.0 (WinXP)
  - Control Panel
    - Add/Remove Programs
    - Add/Remove Windows Components
    - Install Message Queuing Services

- Create message queues using the management console snap-in (run: compmgmt.msc /s)
**MSMQ 3.0 Management**

Management Console Snap-In, run: `compmgmt.msc /s`

Run Samples

- Setup messaging infrastructure
- **Setup sources & TPump scripts**
- Setup database (tables)
- Setup QTool
Setup TPump scripts

- **Pack Factor 10**
  The Pack Factor is the number of statements that will be packed together into a TPump buffer and sent to the database as one multi-statement request.

- **Number of sessions 20**
  (Recommendation for Teradata Demo 4.x: sessions = 1)

- **Checkpoint 30**
  Frequency (minutes) between occurrences of checkpointing

- **ROBUST ON**
  Avoids re-applying rows that have already been processed in the event of a restart (data integrity).

- **SERIALIZE OFF**
  SERIALIZE ON removes deadlock potential between buffers within the same TPump job, when rows with NUPI values are being processed.

TPump: Rules of the Thumb

- **Reduce pack factor** in order to reduce data load latency and improve real-time availability of single rows.

- **However, high pack factor** and more sessions can increase throughput.

- **Longer runtime (+40%)** when data with errors (1%)

- **Longer runtime with a NUSI (+50%), worse with 2 NUSIs (+100%); NUSI = non unique secondary index**

- **Longer runtime (+45%)** with fallback

- **SERIALIZE adds 30%, ROBUST adds 15%**
Real-time information about TPump

TPump Job
- BTEQ Output
  - Audit Trail
- TPump Output
  - Audit Trail
- Monitor Table
  - Periodic progress check
  - Get # of errors per minute
  - Enables trend analysis
- Notify Exit
  - Event driven feedback
  - Can drive alert to DBA
  - Job termination code
- Journal Table
  - Backup (reapply)
  - Source for FK Deletes
  - Reprocessing errors

Run Samples

- Setup messaging infrastructure
- Setup sources & TPump scripts
- Setup database (tables)
- Setup QTool
Using Teradata V2R4.x

- Verify connection to database server (TPump uses CLI):
  - Check `\winnt\system32\drivers\etc\hosts`

- Check for access module in `\winnt\system32`
  (MSMQ_AXSMD.DLL)

Using Teradata Demo 4.x

- Teradata Demo 4.0: Win2K, Win NT4
- Teradata Demo 4.1: Win2K, WinXP (Patch required!)
  Download WinXP Patch:
  http://www.teradata.com/solutions/Files4XP.zip

- Check TPump (version 1.4.0 or later required)
  `\Program Files\NCR\Teradata Client\bin\tpump.exe`
- TPump parameter: `sessions = 1`
- Setup of messaging infrastructure:
  - MSMQ must be configured in **Workgroup mode**
    on a standalone **Win2K** machine
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QTool Overview

QTool is:

- A tool designed to enable continuously loading a data warehouse
- MSMQ management utility
- Basic job-scheduler

QTool is NOT:

- A messaging facility
- A DWH loading tool
- A complete, standalone solution to continuous loading
Basic Features of QTool

- Queue monitoring & statistics
- Queue creation, emptying and deletion
- Enqueuing a flat file
- Schedule a „Continuous TPump Job“
- Path configuration at runtime

Queue Monitoring

- Graph showing messages in queue per second
Queue Monitoring

- Create queues
- Empty queues
- Delete queues
- Count messages in queue
  - Show graph
  - Show raw data
- Send job-rotating message (EOJ)
**Basic Features of QTool**

- Queue monitoring & statistics
- Queue creation, emptying and deletion
- Enqueuing a flat file
- Schedule a "Continuous TPump Job"
- Path configuration at runtime

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**Enqueuing a Data File**

![Enqueuing a Data File](image)
Queued Messages

Enqueuing Data

- Specify data file
- Specify queuing rate
- Specify total number of records
- Specify number of records per message
- Specify message priority
- Allows to calibrate
- Show statistics
Qtool Scheduler

**Machine:**
- Owner Paths: private\brump\queue
- Messages: 632

**Shell Command:**
- Windows system 32 commands

**Bespoke Executables:**
- TPump TPump.exe

**TPump Executables:**
- TPump TPump.exe
- TPump TPump.exe
- TPump TPump.exe

**Job Script:**
- TPump TPumpDemojob1.bat
- TPump TPumpDemojob2.bat
- TPump TPumpDemojob3.bat

**Show:**
- Continuously updated job info
- Check output files by double clicking into results table

QTool TPump Scheduling

- Specify paths to executables
- Specify paths to script-files
- Specify job-rotation interval
- Shows continuously updated job info
- Check output files by double clicking into results table
Output files

- Every script generates output file to specified directory

QTool Technology

- Frontend written in Java2SE (1.3.1, 1.4.0)
- Uses Java Native Interface (JNI)
- Backend written in C/C++
  - Accesses Standard MSMQ 2.0 API through C++ COM Interface
  - Accesses MSMQ Management 2.0 API through C COM Interface
Run QTool

- Components:
  - QTool_2_4.jar
  - QToolNative.dll
    Copy DLL into \winnt\system32\n  - MSMQ_AXSMOD.dll
    Copy DLL of access module into \winnt\system32\n  - Installed J2SE runtime environment necessary

- Setup messaging infrastructure
- Setup sources
- Setup TPump scripts
- Setup database (tables)

- Run QTool:
  java -jar QTool_2_4.jar

QTool Demo

Loading additional POS data into a fact table

- Environment: Win2K / WinXP
- Teradata Demo 4.x
- QTool Version 2.4
Near Real-Time Data Integration

Workshop Agenda

- Active Warehouse
- Continuous Data Integration
- Need for Messaging Infrastructure
- TPump in a Continuous Environment
- ADW CoE Sample
  - Content
  - Customization
  - Setting up MSMQ
    - MSMQ 2.0 (W2K)
    - MSMQ 3.0 (WinXP)
  - Setting up TPump & database
- Data Feeds for MSMQ
- TPump Job-Scheduling
- QTool
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- Results & Comparison
  - ADW CoE Sample, QTool
  - MSMQ, MQSeries
- Break / Discussion
- Conclusion / Discussion

Comparison & Results

- QTool:
  - is up to 3 times faster than Source Feeder of ADW CoE sample.
  - one integrated tool, including queue monitoring.
  - has the ability to pack several datasets into one message – TPump automatically copes with that.
  - can assign various priorities to messages.
  - has dynamic environment configuration (instead of hard-coded paths).
- ADW CoE sample has some additional features not implemented in QTool: FDL output, Timestamps.
- MSMQ access module of the ADW CoE sample is not as sophisticated as MQSeries access module.
Results for Single Load Jobs

- High performance data integration is the real challenge:
  - **Teradata Demo 4.1**, Win XP  
    Notebook: Pentium IV, 512 MB RAM  
    MSMQ 3.0: ~ 260 msg./sec.

  - **Teradata V2R4.1**, 100 MBit/s Network, NCR S28 Server  
    MSMQ 2.0: ~ 47 msg./sec.  
    MSMQ 3.0: ~ 69 msg./sec.

  - **Teradata V2R4.1, ADSL Connection**, NCR S28 Server  
    MSMQ 2.0: peaks with 20 msg./sec.

Summary

- Motivation for continuous data integration:  
  having up-to-date data for better and faster decisions
- Detailed investigation of Continuous TPump Environment
- Using TPump in a MSMQ environment
- Setting up a Proof of Concept (with QTool)
- Explaining the issues & pitfalls
- Comparisons and results
Near real-time data integration works!

- Carefully analyze your requirements.
- Teradata provides powerful integrated load utilities (fastload, multiload, tpump).

Thank You!