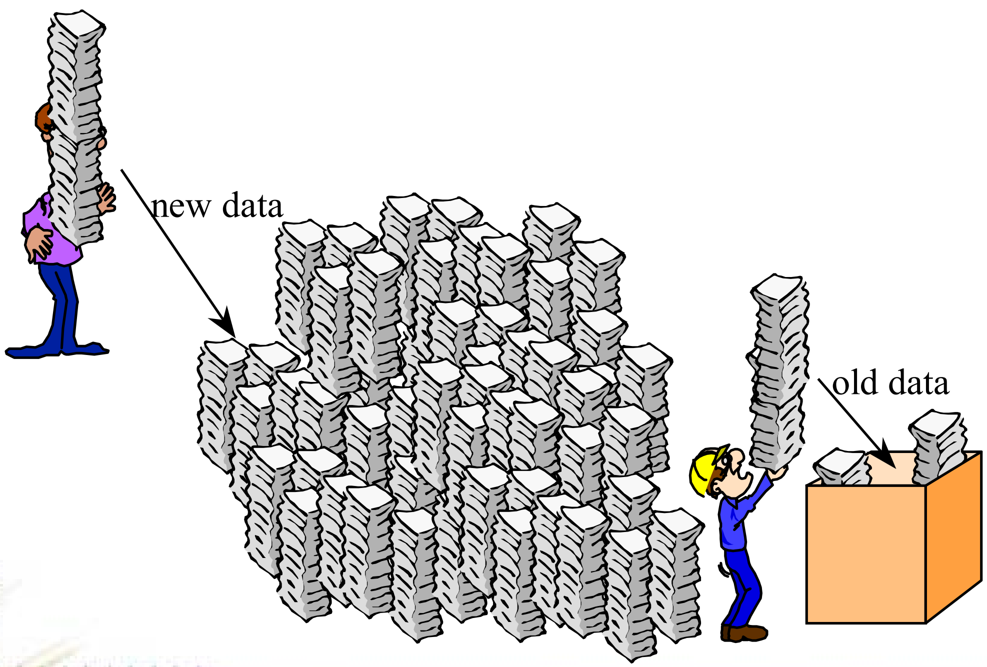
A Cross Comparison of Data Load Strategies



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Talking Points

- **Data Maintenance Requirements**
- **Load Time Breakdown**
- **Transformation and Cleansing**
- **“Updates”: Load Utilities and SQL**
  - How they work
  - Performance Characteristics
    - including base table load and index, fallback maintenance
  - Maximizing performance
- **Load Strategies**
  - Performance Comparison of Load Techniques
  - Strategies for Real-Time Availability
  - Strategies for Minimal Load Times

Disclaimer

- **Rates shown achieved on**
  - 2x5200 (550MHz)
    - Extrapolate rates up 9% for current 5300 nodes.
  - 1 WES (Ver. 3.0) Array Cabinet,
  - 80 10K RPM drives, RAID1 (mirroring)
  - 20 AMPs,
  - Client: 4400 (450MHz),
  - Client to Teradata DBMS: Dedicated 100 MB private LAN.
  - Teradata V2R4.x
  - Controlled Environment.
  - Our SQL and Database Demographics.

Your rates will vary from our rates.

Data Load Requirements

- **What's the Goal?**
  - Real-Time Data Availability
  - Minimized Delay Data Availability
  - Minimized Load Times
    - Archival data loading
- **How does workload mix impact data load requirements?**
  - Dirty Reads?
  - Lock Contention?

	(Delayed Availability)
Real-Time Availability	Minimal Load Time
←	→
Low Update Rates	*High Update Rates*

Data Elimination Requirements

- **What's the Goal?**
  - Minimize Data Storage
    - Solution: MultiLoad Delete Task
  - Minimize Query Response Times
    - Archive table separate from Active table

Load Time Breakdown

- **End-to-End Time to load includes**
  - Receipt of Source Data
  - Transformation & Cleansing
  - Acquisition
  - Target Table Apply
  - Fallback Processing
  - Permanent Journal Processing
  - Secondary Index Maintenance
  - Statistics Maintenance

“Update” Utilities and SQL

Update Method	E Receipt of Source	T Transform	L Acquisition	L Apply	L Fallback	L Permanent Journal	L Secondary Index, etc.	L Statistics
TWB Load (FastLoad)	☺	*Partner / DBMS* ☺	☺	☺	☺	☺		*Use Statistics Wizard*
TWB Update (MultiLoad)	☺	☺	☺	☺	☺	☺	☹	
TWB Stream (Tpump)	☺	☺	☺	☺	☺	☺	☺	
SQL Merge Ops: Insert-Select, Update-Join, Delete-Join	*Use TWB Load to staging table*			☺	☺	☺	😐	

Load Utilities - FastLoad, Multiload, TPUMP

- **Restrictions**
  - Fastload
    - Inserts only
    - Empty Target Table Required
    - Fallback, Permanent Journal are applied after the Fastload is complete
    - Secondary Indexes, Triggers, Join Indexes and Referential Integrity must be applied after the Fastload is complete.
  - Multiload
    - Unique Secondary Indexes, Triggers, Join Indexes and Referential Integrity must be dropped before and recreated after the Multiload.
  - TPUMP
    - No Restrictions!

Best for mixed workloads & real time data availability.

"Update" Utilities and SQL: Restartability & Accessibility During Load

Update Method	Checkpoint / Restart	Rollback	Permanant Journalling	Locking & Access
TWB Load (FastLoad)	Yes	No	No	Exclusive Write
TWB Update (MultiLoad)	ACQ: per your specification. Apply: Every datablock	No	Yes	ACQ: Table Access Apply: Table Write
TWB Stream (Tpump)	Yes	Yes	Yes	**Row hash Write**
SQL Merge Ops: Insert-Select, Update-Join, Delete-Join	No	Yes	Yes	Table Write

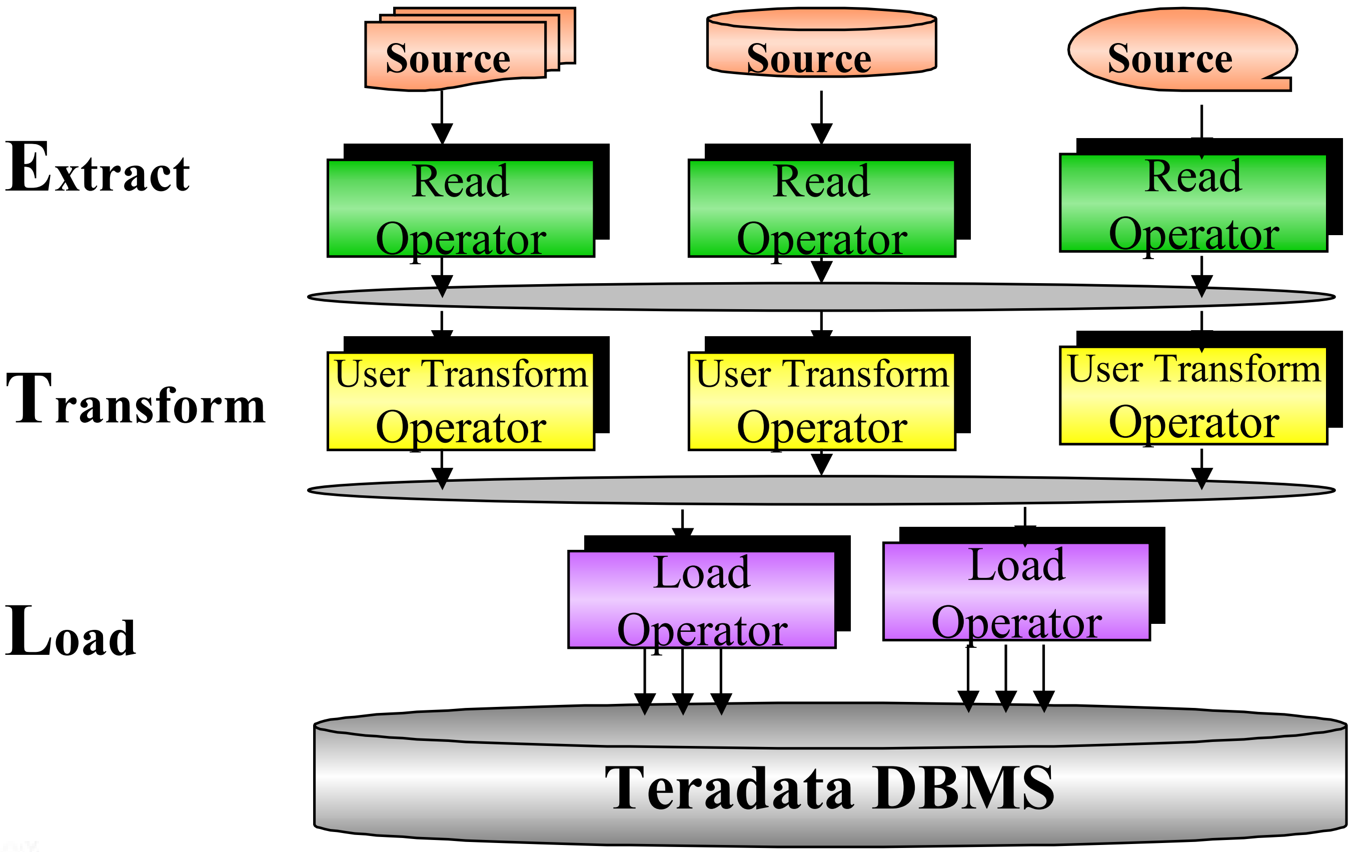
Best for mixed workloads & real time data availability.

Load Utilities - Teradata Warehouse Builder

- **Seamless Integration of Extract, Transformation & Load Ops**
  - Parallelizes Extract, Transform and Load Acquisition Operations for improved performance.
  - Data Streams eliminate intermediate data stores.
    - Data Streams are Teradata Warehouse Builder's merge-able, split-able pipes.
    - Data store limitations not an problem.

      E.g: 2GB Maximum UNIX file size.
    - Less work means even better performance.
- **Easy Data Extraction**
  - Can extract from heterogeneous data sources, e.g. files, relational tables, sources with different schema.
- **Compatible with Partner Products for Complex Transformation**
- **Feeds the load utilities <u>with parallelism</u> through load operators:**
  - Load (aka Fastload)
  - Update (aka Multiload - insert, update and delete)
  - Stream (aka to TPUMP - insert, update and delete)
  - Export (aka Fastexport).

Load Utilities - Teradata Warehouse Builder



Teradata Warehouse Builder Acquisition Phase - Maximizing Performance

- **Use Teradata Warehouse Builder features to eliminate ETL steps and intermediate data stores.**

- **Choose level of parallelism to maximize acquisition performance:**
  - More parallel feeds to the point of saturating client
  - Fewer parallel feeds to reduce client management overhead
  - Choice of parallelism application dependent (I.e.: complexity of read and transform operators, speed of source media.)
  - Teradata Warehouse Builder eliminates the old ‘bottlenecked on single source feed’ issue, enabling fuller utilization of Teradata during acquisition phases.

Teradata Warehouse Builder Acquisition Phase - Maximizing Performance

- **Consider client processing demands & resource availability**
  - Client resources are shared by other tasks
    - (e.g. transformation and read operators)
  - Client CPU demands (most to least):
    - TPUMP > MultiLoad > Fastload

- **Consider concurrency effects to yield a saturated DBMS.**
  - 2-3 concurrent Fastloads and Multiloads will saturate the DBMS in the apply phase.
  - 1+ utility in apply phase and 1+ utility in the acquisition phase mix well.
  - If one TPUMP is not powerful enough to saturate DBMS, use multiple TPUMPs.

Transformation and Cleansing

- **<u>Where to do it?</u>**
  - Consider the impact on load time.
    - Where is all the required data?
      - Move Teradata Data to Client then load to Teradata: export-transform-load
      - Move Client Data to Teradata: load-transform *or* load to staging-transform-load
    - Teradata side advantage: *<u>Parallelism</u>*
      - Almost all transformations can be done with SQL/Utilities
  - Guideline:
    - Simple Transformations: Transformation pipe to load utility
    - Complex Transformations: Transform on Teradata DBMS
    - When in Doubt: Measure
- **<u>Can Transformations be eliminated?</u>**
  - Evolve source feeds to a compatible format

Maximizing Performance: More on Simple Transformation

- **Definition of Input Data**
  - Avoid generated NULLIF & concatenated constructs on .FIELD cmds
    - Use SQL NULLIF and Concatenation for parallelism and reduced client CPU usage.
    - Ie: Do this transformation on the DBMS!
  - Use .FILLER wisely
    - Client can “block copy” input to parcels instead of “field-by-field copy” if no .FILLER, no varchar/byte and no generated fields. Consider bytes saved from transferring via .FILLER vs inefficiencies of “field-by-field copy”.

Maximizing Performance - More on Cleansing

- **Unclean data pushes inefficiencies into the apply phases. E.g.**
  - Duplicate Unique Index Values
  - Duplicate Rows
  - Constraint Violations
- **All unclean data is put to load error tables.**
- **Multiload error processing is handled one row at a time.**
  - Economies of scale lost
- **TPUMP error processing causes rollbacks.**
  - Highest error processing penalty of all load methods.
- **Where to clean?**
  - Measure to determine best option.

Load Utilities - FastLoad, Multiload, TPUMP

- **Potential Load Rates: Fastest to Slowest**
  - <u>Fastload</u> is Fastest!
  - <u>Multiload</u> is fast or slow, depending….
    - Multiload can *almost* yield Fastload rates if the conditions are right:
      - Higher percentage of source data to target table/partition data yields higher load rates
    - Multiload can be slower than TPump if the conditions are wrong
  - <u>TPUMP</u> has the slowest potential rate
    - TPUMP ALWAYS processes 1 row update at a time.

MultiLoad Acquisition

- **Acquisition Functionality:**
  - Receive data from host and send directly to AMPs.
    - For Deletes & Updates, send only required part of the row.
    - For Inserts, send the whole row.
  - Redistribute & Sort data by hash.
- Performance trend is linear based on bytes to load.
  - *This DBMS rate assumes client and connectivity are not bottlenecks.*
    - Customers using big AIX, Solaris and HP-UX with single or dual GB Ethernets seldom have such a bottleneck….

Delete/Update Estimate:
<u>(# of rows to update/node)</u>
(80,000 rows/sec/node)

Insert/Upsert/Mixed-Action Estimate:
<u>(MBytes to download/node)</u>
(2.9 MBytes/sec/node)

- *Note: Delete Task has no acquisition phase.*
- *Increase estimated time by 1.6X if table is fallback protected.*

MultiLoad Apply Primary Table

- **Functionality:**
  - Apply sorted data a block at a time into the target table.
- Performance Trend depends on number of rows/DB affected.
  - Throughput increases as rows/DB increase to a peak rate.*

Determining number of rows/DB affected (X):

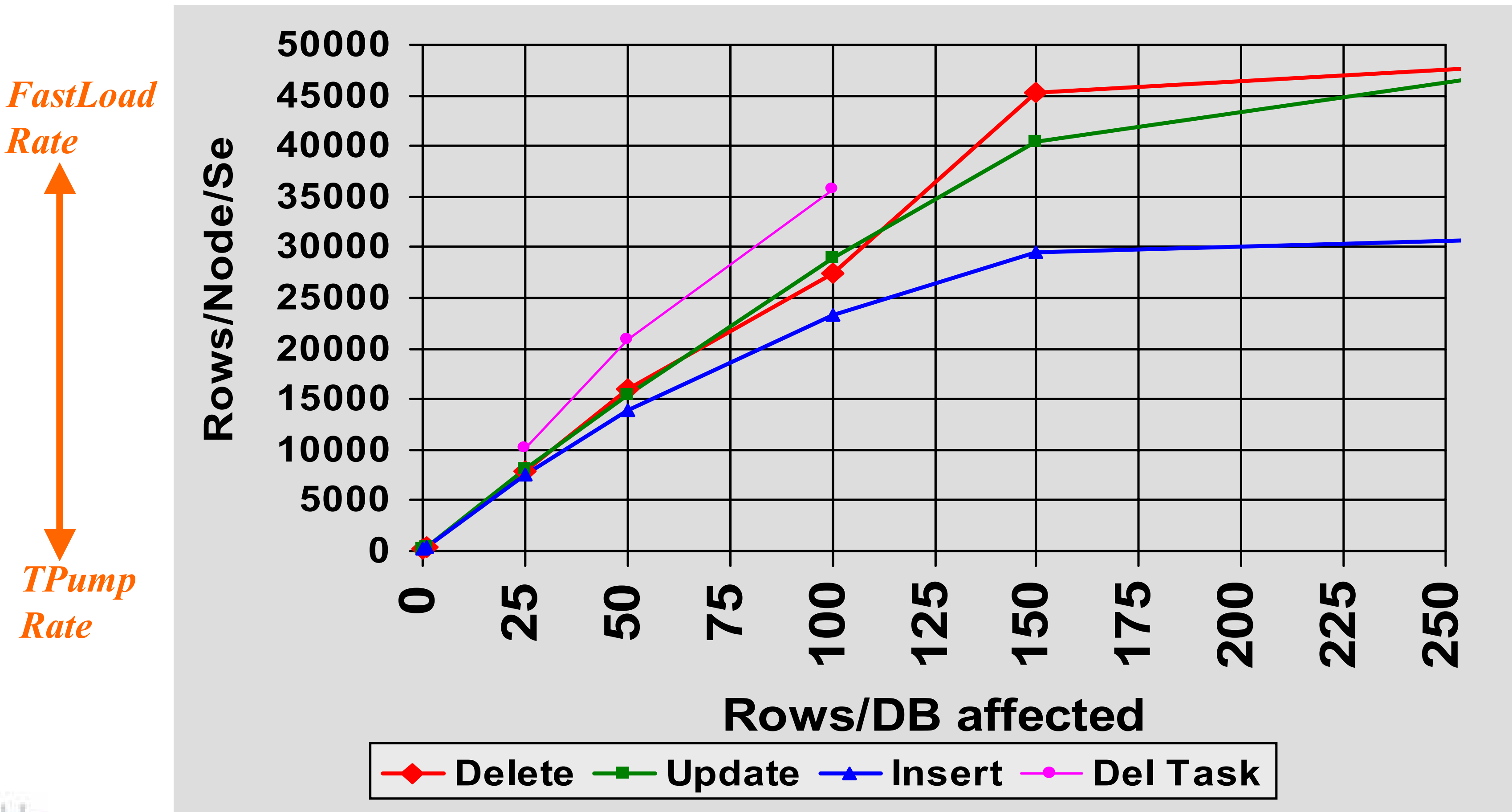
- ***X = P * N***
  - % of target table affected: ***P* = *<u>(rows to MultiLoad)</u>***
    (target table rows)
  - Total rows/DB: ***N* = TRUNCATE(*S / rowsize*)**, where
    Typical DB size ***(S)*** is 75% of maximum DB size.
    - e.g.. If Max DB size is 63.5K, typical is 63.5K*.75=48K
- ***Example:***
  - ***100 rows fit into a datablock (N).***
  - ***We are adding 10% more data to the table. (P)***
  - ***We are therefore adding 10% more data to all datablocks.***
    i.e..: X = P * N = .10 * 100 = 10 rows/DB affected

Apply Time =
<u>(Rows to load/node)</u>
(Y rows/sec/node)

See next slide
for 'Y'

- * Processing time accumulates mostly 'per row' and 'per datablock', not 'per byte'.
- * Datablock size has some impact on throughput rates.
  - Larger datablocks greatly improve the total response time of an update, but not fully by the corresponding increase in hits/datablock it results in. 'Per datablock' processing time is larger with larger datablocks than it is with smaller datablocks.

MultiLoad Apply Primary Table



Apply Time = *<u>(Rows to load/node)</u>*
(rows/sec/node rate for your hits/db)

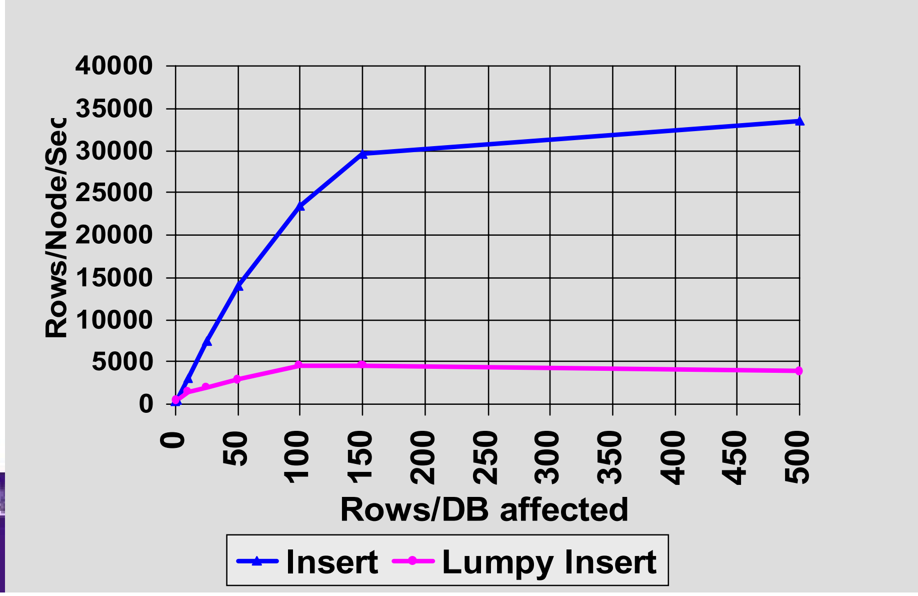
MultiLoad Apply Primary Table

- **What about Upsert Performance?**
  - Per datablock, MultiLoad first tries to update the row. If that fails, it re-issues the command within the DBMS as an Insert. (The datablock is still only committed once.)
  - Example for estimating Upsert apply time:
    - Upsert of 100,000 rows will result in 50% Inserts, 50% Updates.
    - Apply time ~= time to do 100,000 updates PLUS time to do 50,000 inserts.

      Use the insert and update rates at the hits/db you get with the original 100,000 rows. (not 150,000 or 50,000 rows.)

MultiLoad on NUPI Tables / Lumpy Inserts

- **All data shown thus far assumes prime index is UPI.**
- **MultiLoad with highly non-unique NUPI can reduce performance.**
  - Multiset reduces this difference to insignificant by eliminating duplicate row checking.
  - NUPI MultiLoad (w/ or wo/ Multiset) with few (100 or less) rows/value performs like UPI MultiLoad.
- **But if NUPI improves locality of reference, NUPI MultiLoad can be faster than UPI MultiLoad!**
  - Lumpy NUPI Inserts can be orders of magnitude faster than UPI Inserts
  - But... Performance rates at X hits/DB as a result of lumpiness do NOT approach performance rates at same X hits/DB when evenly distributed.



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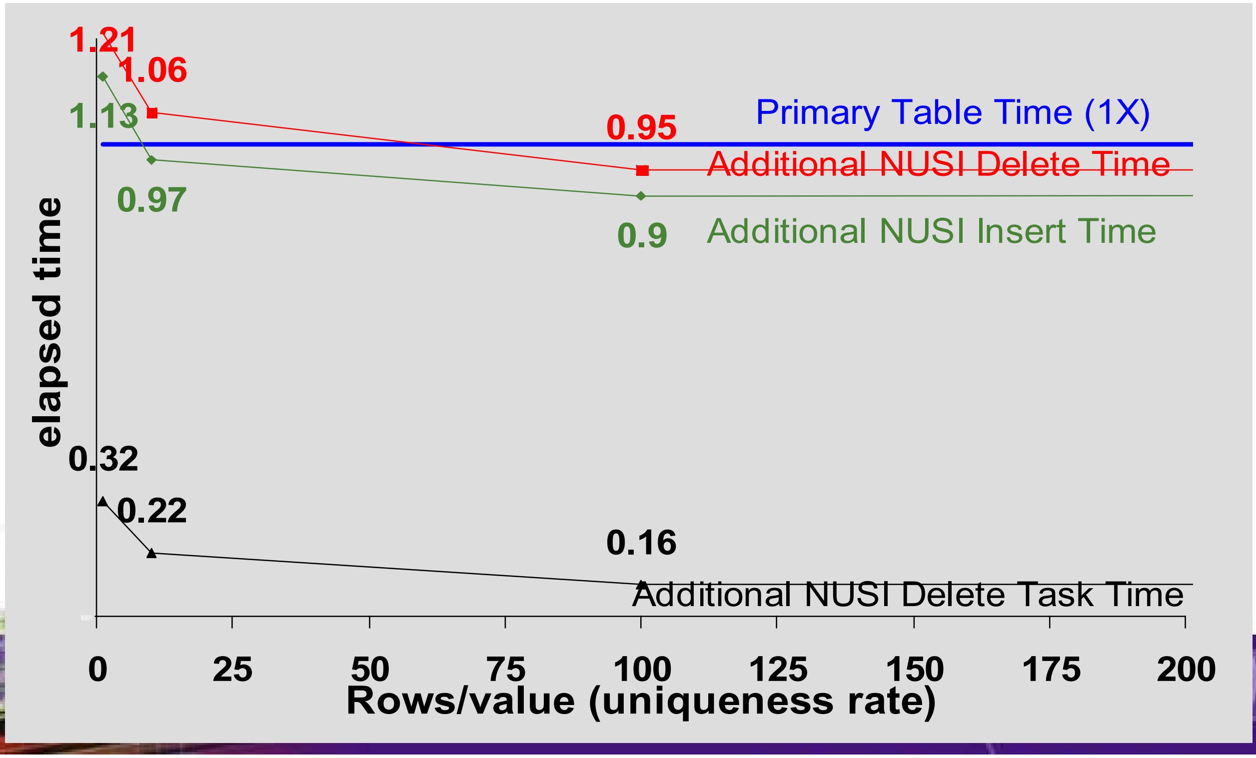
MultiLoad on PPI Tables

- **All data shown thus far assumes non PPI Tables.**
- **MultiLoad to a PPI table can greatly improve locality of reference.**
- **Unlike lumpy NUSI data, performance of this type of locality of reference yields SAME performance benefit as non partitioned / high hits/db situation.**

- **Consider instead: What’s the hits/db in the target PARTITION?**
  - Apply estimated time according to this hits/db.

MultiLoad Apply NUSI, Fallback, Journal

- **Fallback: Double estimated times to load both primary and NUSI tables if fallback.**
- **Permanent Journal: Additional time required to maintain.**
- **Functionality of NUSI maintenance:**
  - Generate NUSI change rows while applying primary table rows
  - Sort NUSI change rows
  - Apply NUSI change rows to NUSI tables



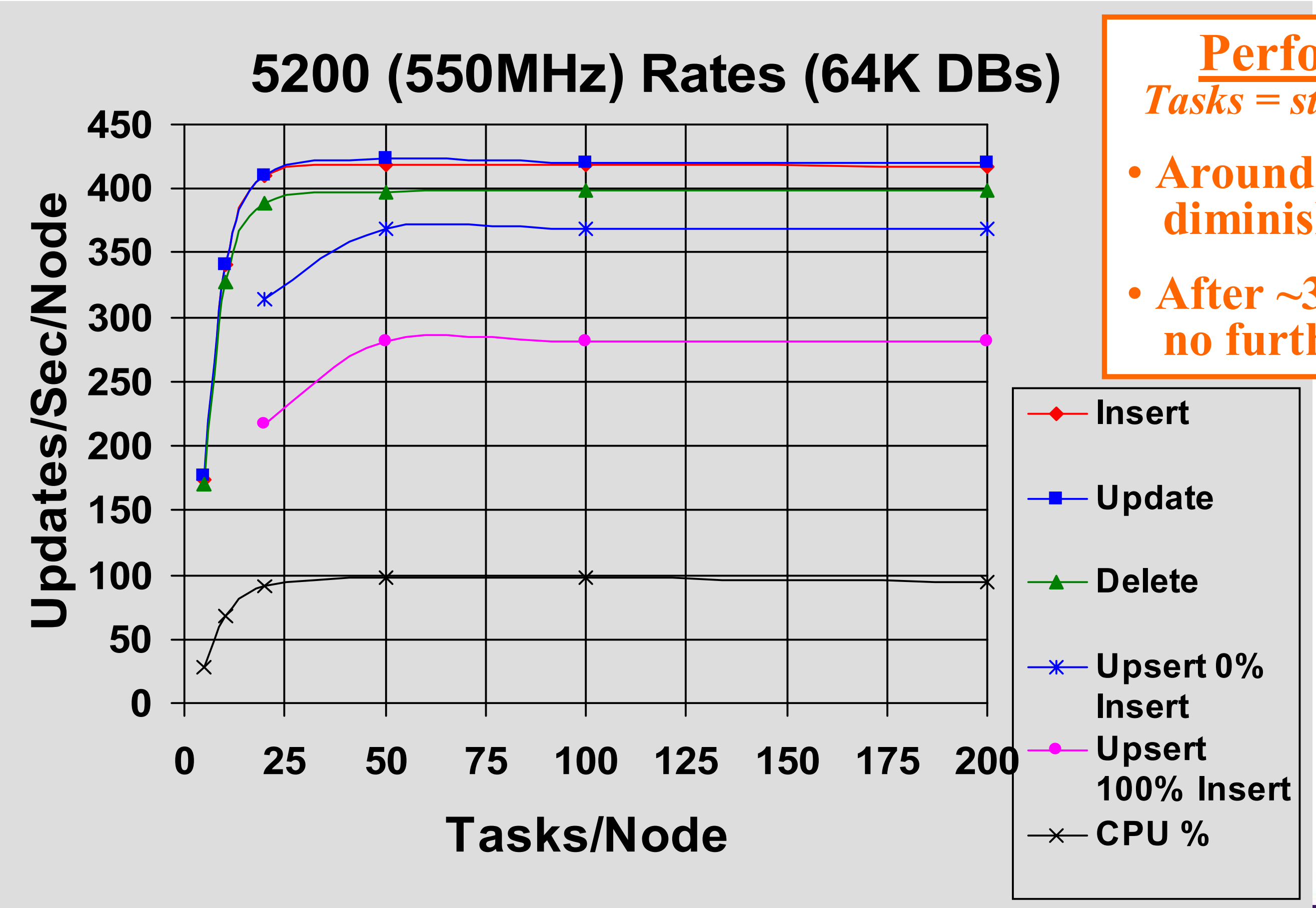
MultiLoad - Maximizing Performance

- **Go for the highest hits per datablock ratio**
  - Do one, not multiple MultiLoads to a single table
  - Do less frequent MultiLoads
  - Load to smaller target tables, or to PPI partitions
    - active vs archive table partitions
  - Reduce your rowsize
    - Multi-Value Compression
  - Use large datablock sizes

Balance your choices against real-time availability goals and impacts on DSS work.

Load Utilities: TPUMP UPI Updates Trend (DBMS Capability)

- **DBMS Functionality: Primary Index Access for Inserts, Updates, Deletes on tables as issued from TPump or other**



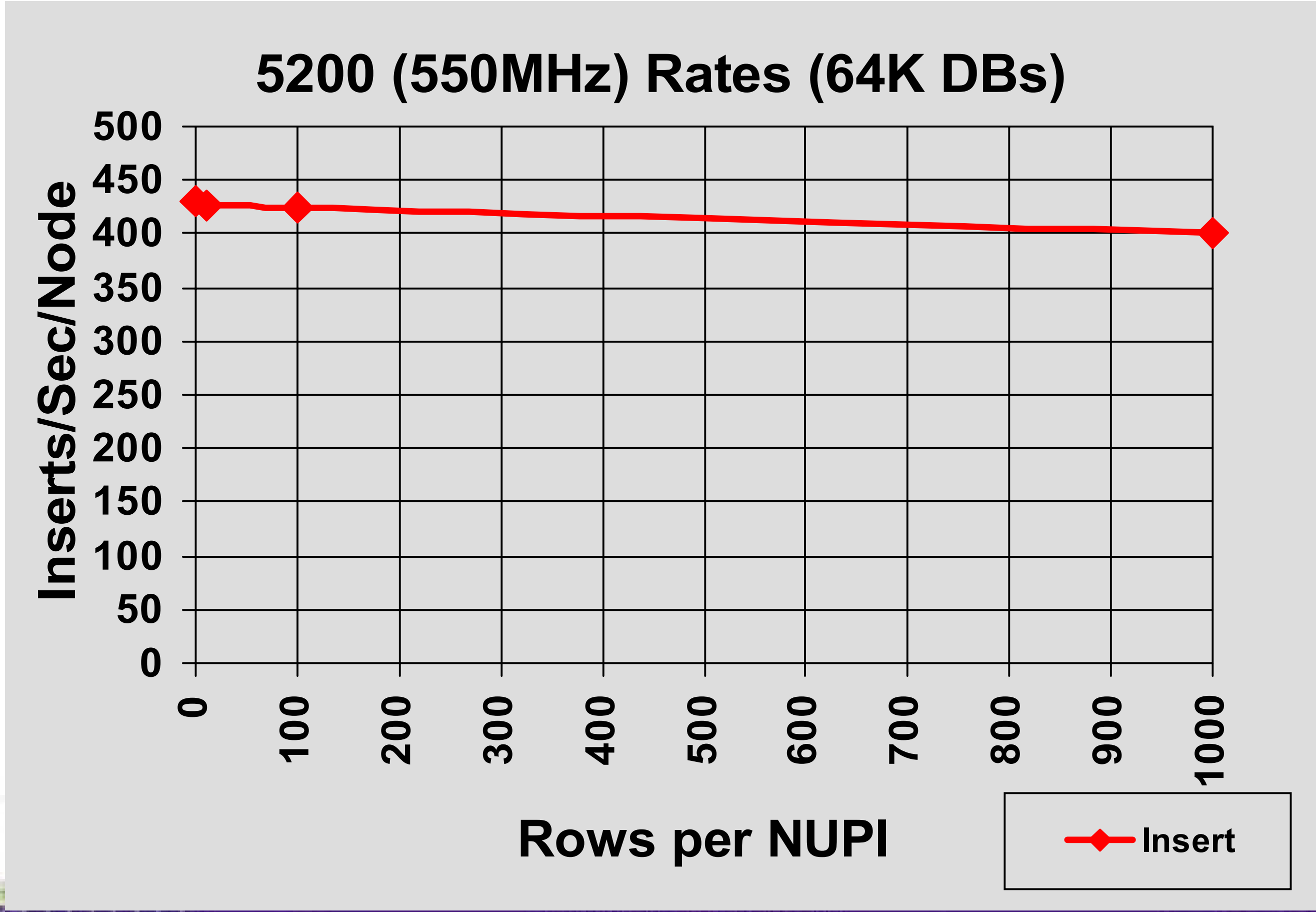
Performance Trend

*Tasks = stmts/request * sessions*

- **Around 20 tasks/node diminishing returns set in.**
- **After ~30-40 tasks/node, no further gain.**

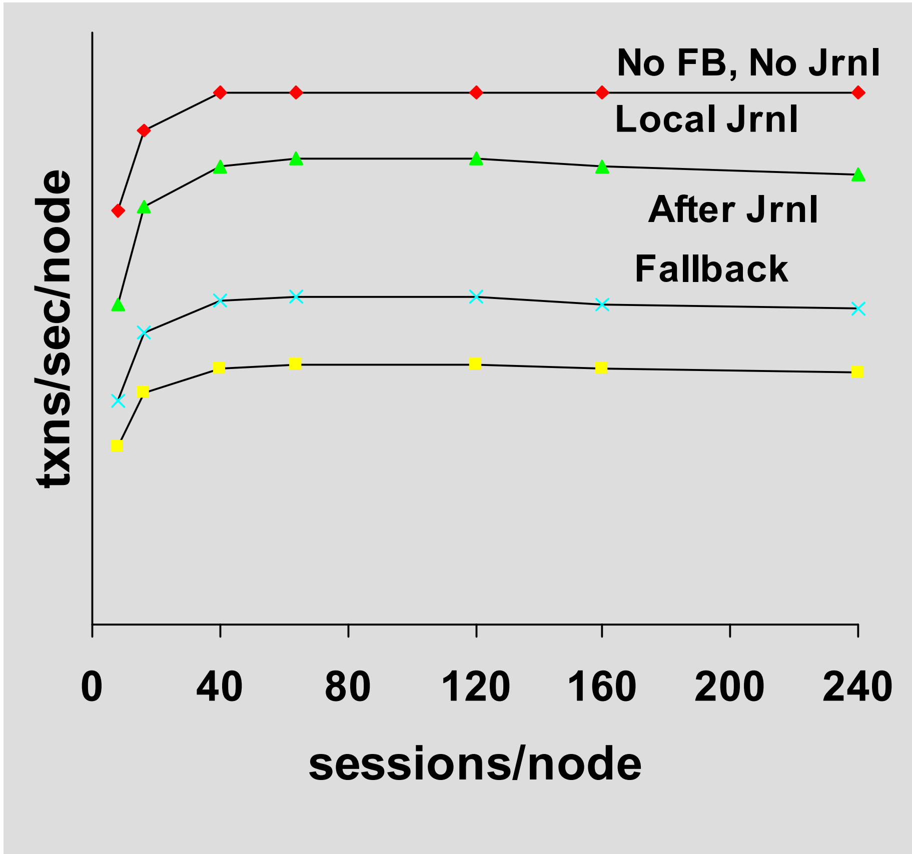
Load Utilities: TPUMP NUPI Updates Trend (DBMS Capability)

- **NUPI cost is minimal.**
  - 10% reduced performance at 1000 rows/NUPI vs 1 row/NUPI.



Load Utilities: TPUMP Updates Fallback and Permanent Journal Costs

- **Fallback: Reduce throughput by 2X.**
  - e.g.: 100 txns/sec No Fallback -> 50 txns/sec w/Fallback
- **Local Journalling (Before, Local After): Reduce throughput by 1.2X.**
  - e.g.: 100 txns/sec No Journalling -> 83 txns/sec w/Local Journal.
- **After Journalling: Reduce throughput by 1.75X.**
  - e.g.: 100 txns/sec No Journalling -> 57 txns/sec w/Local Journal.



Load Utilities: TPUMP Updates Cost of Index Maintenance

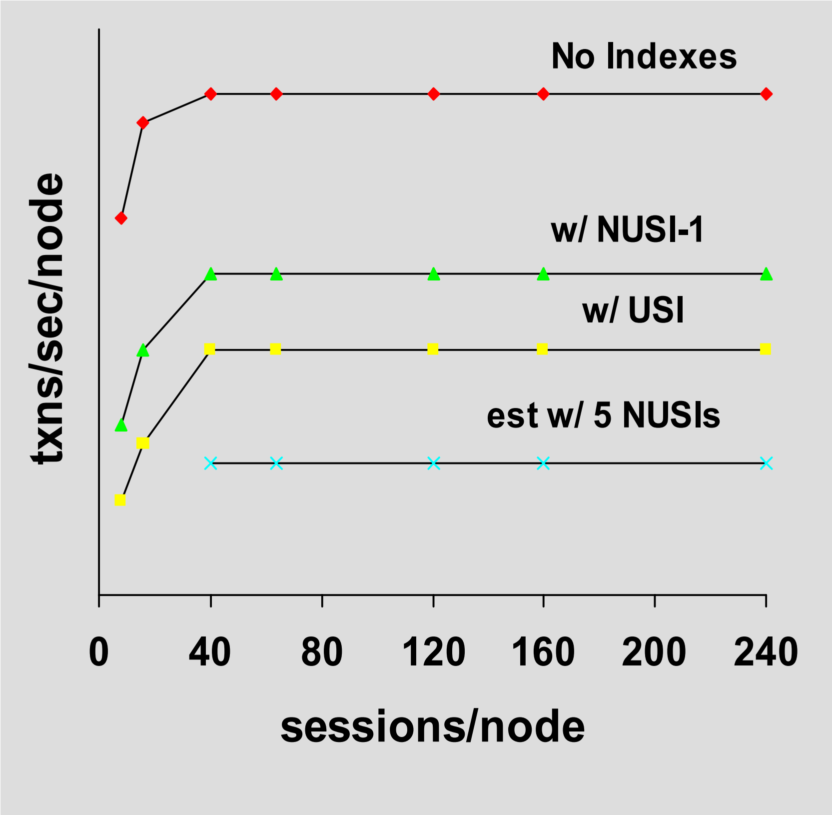
USI Cost

- Change row sent to owning AMP.
- Additional CPU/USI is ***1.0X*** the CPU path of primary table insert/delete.
  - E.g: If it takes 100 seconds for the primary inserts/deletes, it will take an additional 100 seconds to update each USI.

NUSI w/ 1 row/value Cost

- NUSI change row applied locally.
- Additional CPU/NUSI is ***0.55X*** the CPU path of primary table insert/delete.
  - E.g: If it takes 100 seconds for the primary inserts/deletes, it will take an additional 55 seconds to update each NUSI.

NUSI w/ x rows/value Cost expected to be like NUSI w/1 row/value Cost.



- **Join Indexes, triggers, referential integrity,etc. also must be maintained….**

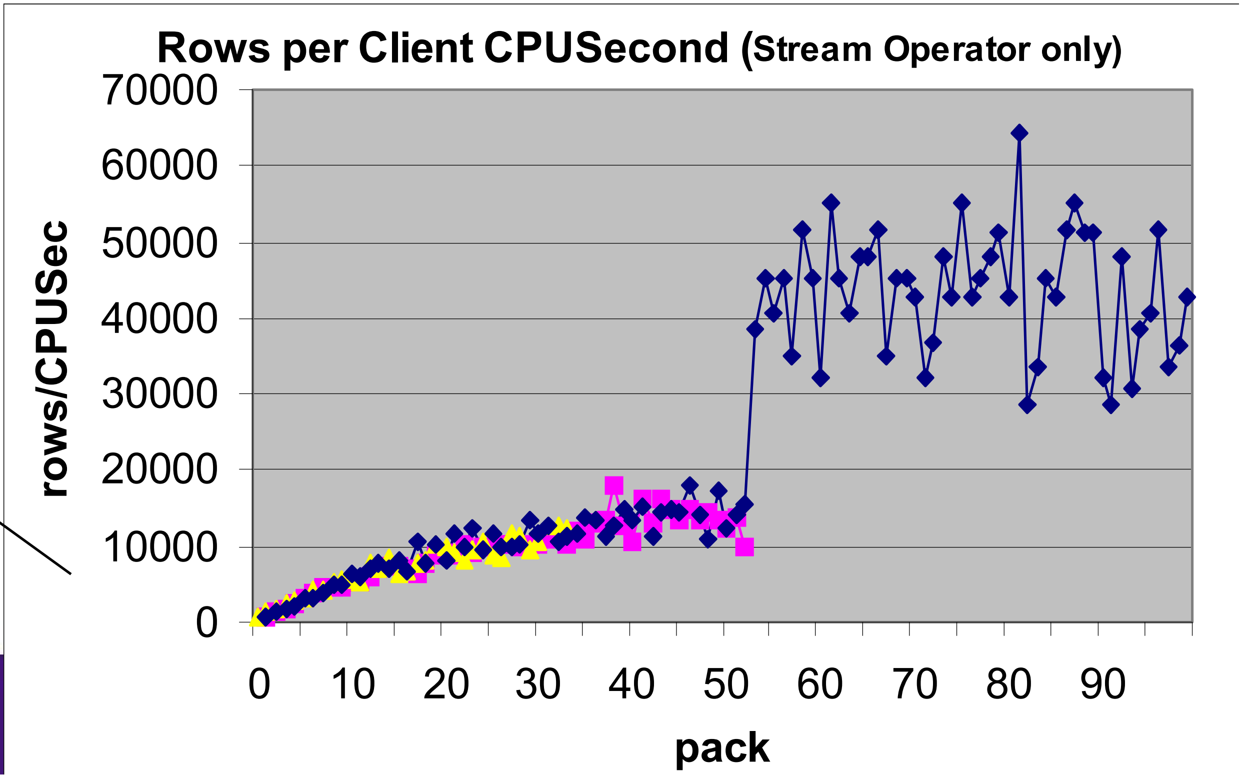
These SI maintenance costs assume index value not updated.

TPump - Maximizing Performance

- **Key to achieving maximum performance is achieving 30+ concurrent tasks/node from the data feed.**
- **Potential Issues achieving enough tasks/node:**
  - Reading Source Media
  - Client processing CPU and availability
  - Connectivity configuration
  - Sessions
  - Pack
  - Errors
  - “Serialize ON”

TPump - Client Processing

- **Client CPU is required for the stream load operator plus transformation and read operators.**
  - 1 Client node running stream load operator only can supply about 100 Teradata Nodes to saturation.
    - Assumes PK Updates with no fallback, no indexes, no journal. If indexes, fallback or journal, 1 client node can supply >100 Teradata Nodes.
  - If one Client node is not powerful enough, consider using more.
    - Partition input data to avoid inter-job row-hash collisions.



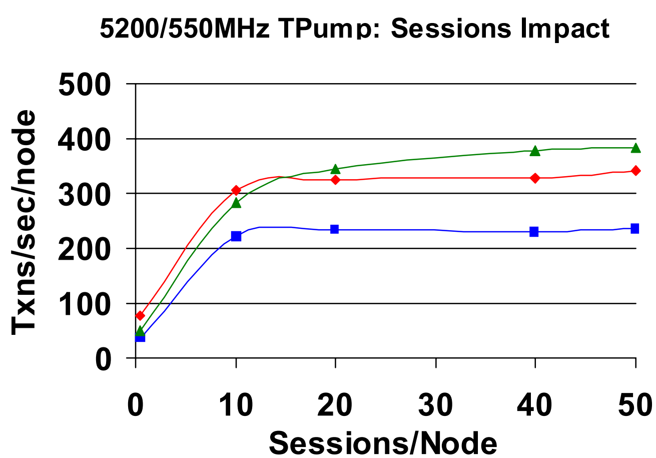
How much Client CPU do I need to drive my desired TPUMP rate?

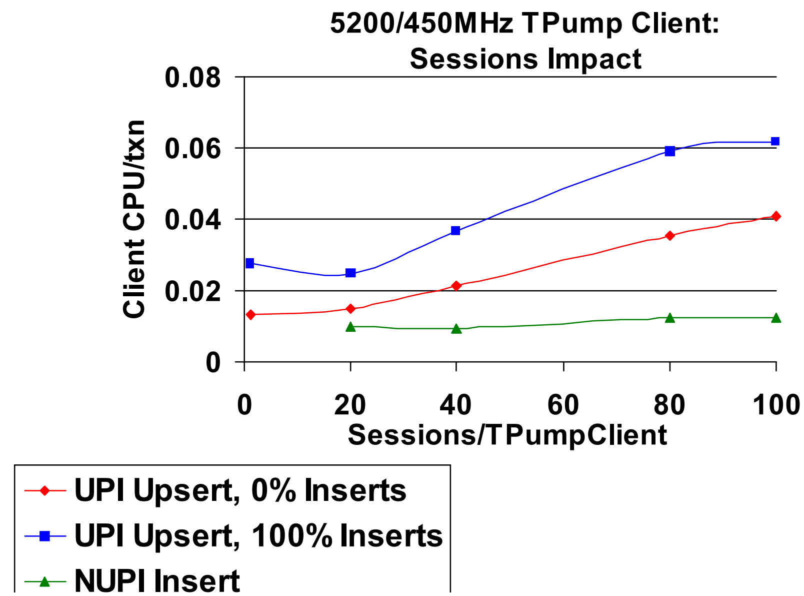
TPump - Maximizing Performance

- **TPump Parameters to maximize feed rates: <u>Sessions</u>**
  - Increase sessions per AMP to saturate client or DBMS
    - Alternatively, increase sessions only to accommodate the maximum load rate desired.

      Sessions, rate and PSF can all be used to limit feed rates.

      PSF is the only way to guarantee a rate.
  - Watch Out! Too many sessions costs
    - Management overhead on client
    - May result in DBMS message congestion
    - May result in row hash lock deadlocks if no serialize.
    - **<u>Try 1 or fewer sessions per AMP.</u>**





TPump - Maximizing Performance

- **TPump Parameters to maximize feed rates: <u>Pack Rate</u>**
  - How many transactions can you fit in a buffer?
    - 2548 Maximum Using Fields (txns * columns) *z higher limit at V2R5*

      Most likely limit to hit first
    - Maximum Pack is 600. *z higher limit at V2R5*
    - Maximum 1M Buffer holds *z higher limit at V2R5*

      Request Parcel

      Data Parcel (Max 65104 bytes less Request Parcel Size)
      - Only issue if data size is larger than 600 bytes/transaction)

      Response Parcel
    - TPUMP will discover your max pack rate for you.

      But only let it do this the first time --- discovery is expensive on client CPU!

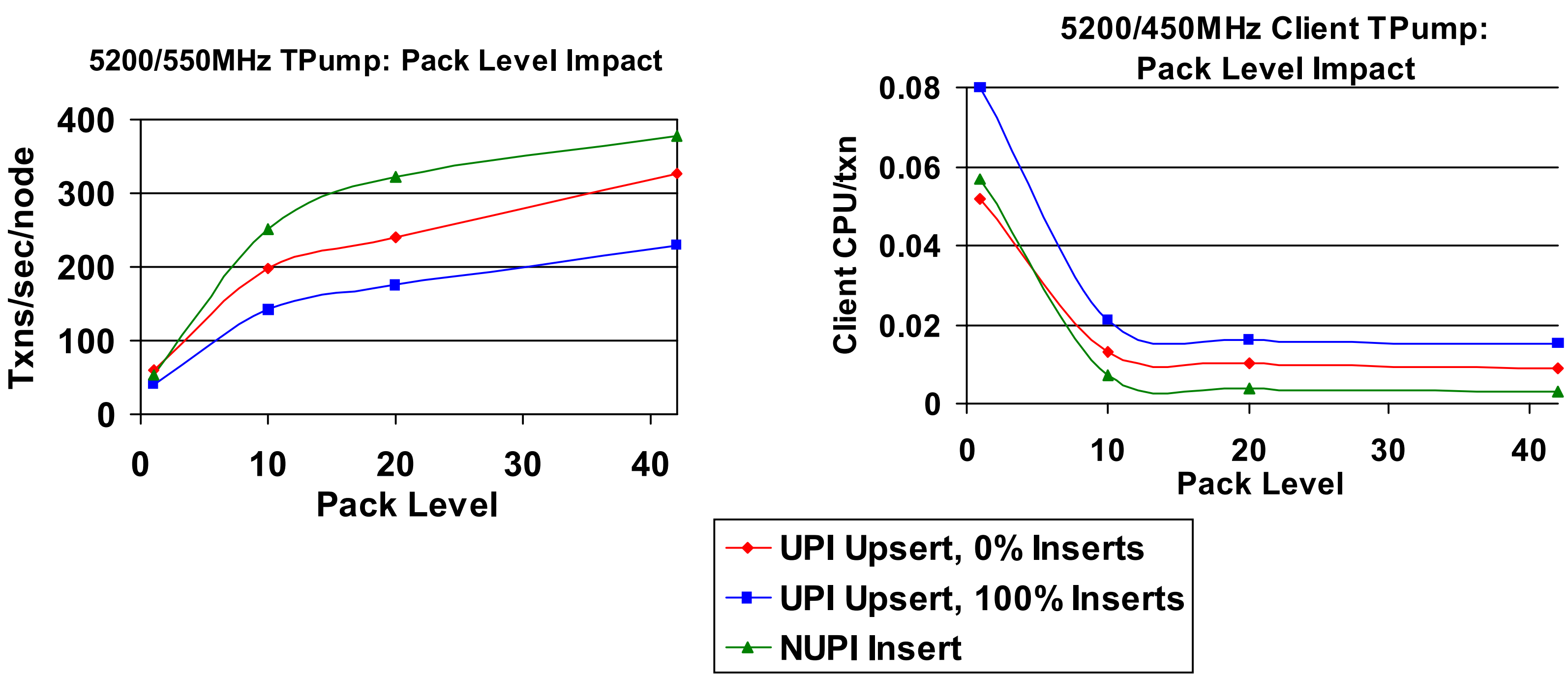
<u>Syntax example (2 columns, 2 txns packed)</u>

```
.LAYOUT lay1a;
.FIELD CUSTOMER_ID * INTEGER;
.FIELD CUSTOMER_NAME * CHAR(40);

.DML
INSERT INTO TABLEX (customer_id, customer_name) values
(:customer_id,:customer_name);
TPump Generates a macro: databasename.M20000802_173302_30_01_0001.
Request becomes
            Using (AA1 int,AA2 char(40),AB1 int,AB2 char(40))
            BT;
            exec databasename.M20000802_173302_30_01_0001(:AA1,:AA2);
            exec databasename.M20000802_173302_30_01_0001(:AB1,:AB2);
```

TPump - Maximizing Performance

- **TPump Parameters to maximize feed rates: <u>Pack Rate</u>**
  - Use highest pack rate possible for your transaction.
  - Higher pack reduces client CPU demand in addition to increasing TPump rate.
    - Is number of columns per row preventing high pack? Try this trick:
      Combine several character fields into a single field then use substr in the SQL...
  - But, higher pack aggravates error processing and partial buffer overhead...



TPump - Maximizing Performance

- **TPump Parameters to maximize feed rates:**
  - Minimize Error Processing and Row Hash Deadlocks
    - Some causes of Error Processing

      Duplicate Unique Index Values

      Duplicate Rows

      Constraint Violations
    - What happens:

      Additional DBMS work and client-to-DBMS traffic to rollback, resolve, re-send and reprocess **all** transactions in the buffer.
    - Cleanse Input data as much as possible before giving it to TPump

Error Processing example (6 txns packed, error on 3rd, 6th txn)

Request sent is Insert1/Insert2/Insert3/Insert4/Insert5/Insert6

DBS applies Insert1/Insert2, gets error on 3rd transaction.

DBS rolls back Insert1/Insert2, sends request back to TPump client.

Client re-sends request as Insert1/Insert2/Insert4/Insert5/Insert6

DBS applies Insert1/Insert2/Insert4/Insert5, gets error on 6th txn.

DBS rolls back Insert1/Insert2/Insert4/Insert5, sends request back to TPump client.

Client re-sends request as Insert1/Insert2/Insert4/Insert5

DBS applies Insert1/Insert2/Insert4/Insert5. Request Completed.

Client sends request & DBS applies ErrTab-Insert3

Client sends request & DBS applies ErrTab-Insert6

Work for 6 True Inserts:

Total Inserts: 12
Total Inserts rolled back: 6
Total requests sent: 5

TPump - Maximizing Performance

- **TPump Parameters to maximize feed rates:**
  - SERIALIZE
    - Guarantees all input records for a given row will be processed on the same session, in input record order.

      Positive Side-effect: Minimizes Row Hash Lock Collisions/Deadlocks.

Cost:

Client CPU Overhead

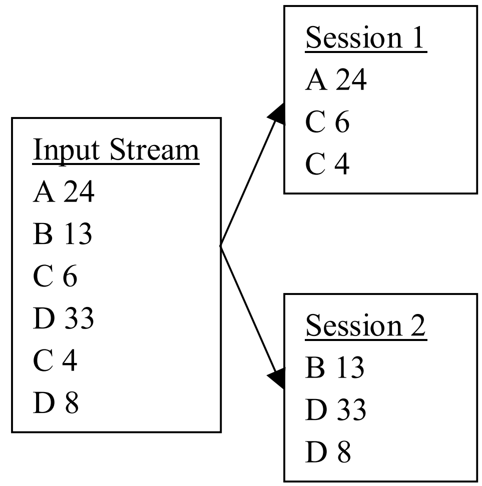
More "partial buffers" for UPSERTs touching same row.

Reduction of average pack rate

Potential session skewing

Have well distributed PI's.

Don't pre-sort the source data



Only use SERIALIZE ON if conditions dictate...

When multiple input records might touch the same row AND the order of application is important.

To minimize row hash lock delays when there are non-trivial row hash synonyms

If using SERIALIZE ON use "-f *10*" to keep clumpy NUPI data moving.

TPump - Maximizing Performance

- **TPump Parameters to maximize feed rates:**
  Partition Sessions by DML
  - Without this partitioning, pack factor is determined by the lowest common denominator.
    - ie: DML with the most columns causes all DMLs to work with a smaller pack factor
  - With partitioning, sessions supporting one DML may have a higher pack factor than a session supporting a different DML to achieve more optimal performance.
  - Partitioning also improves statement cache hit rates. (Statement cache is per session.)
  - Partitioning allows you to specify the number of sessions per DML.

New at V2R5 / TUF7.0

Load Techniques: Combining Fastload with SQL

- **Basic Loading:**
  - FastLoad to staging table ⏩ Insert-Select from staging table to target
  - FastLoad to staging table ⏩ Update-Join from staging table to target

- **Getting the data together for transformations:**
  - FastLoad ⏩ Transform/Cleanse ⏩ Insert-Select

- **Data Elimination:**
  - Fastload ⏩ Delete-Join
  - Delete from tableX where condition;
    - (Just SQL: No Fastload or query from staging table required.)

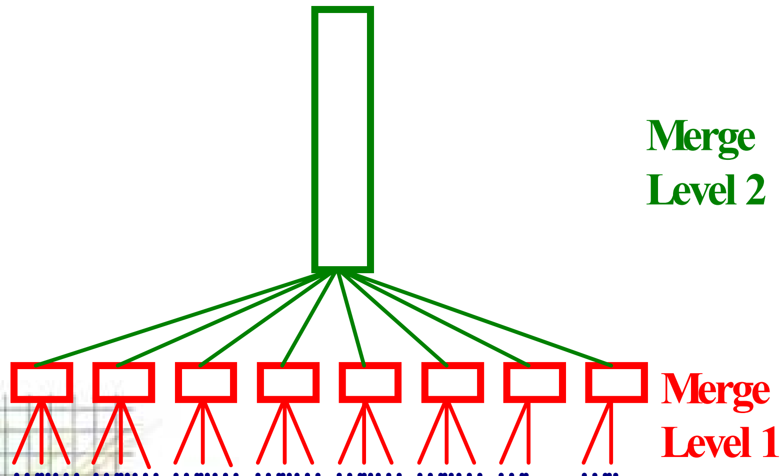
FastLoad Acquisition

- **Acquisition Functionality:**
  - Receive data from client, redistribute to correct AMP.
  - Stores data into multiple 508K buffers. (8 * 63.5K)
  - Sorts each buffer individually.
- Performance trend is linear based on bytes to load.
  - *This DBMS rate assumes client and connectivity are not bottlenecks.*
    - Customers using big AIX, Solaris and HP-UX with single or dual GB Ethernets seldom have such a bottleneck….

$$\text{Acquisition Time} = \frac{\textit{(Mbytes to load/node)}}{\textit{(5 Mbytes/sec/node)}}$$

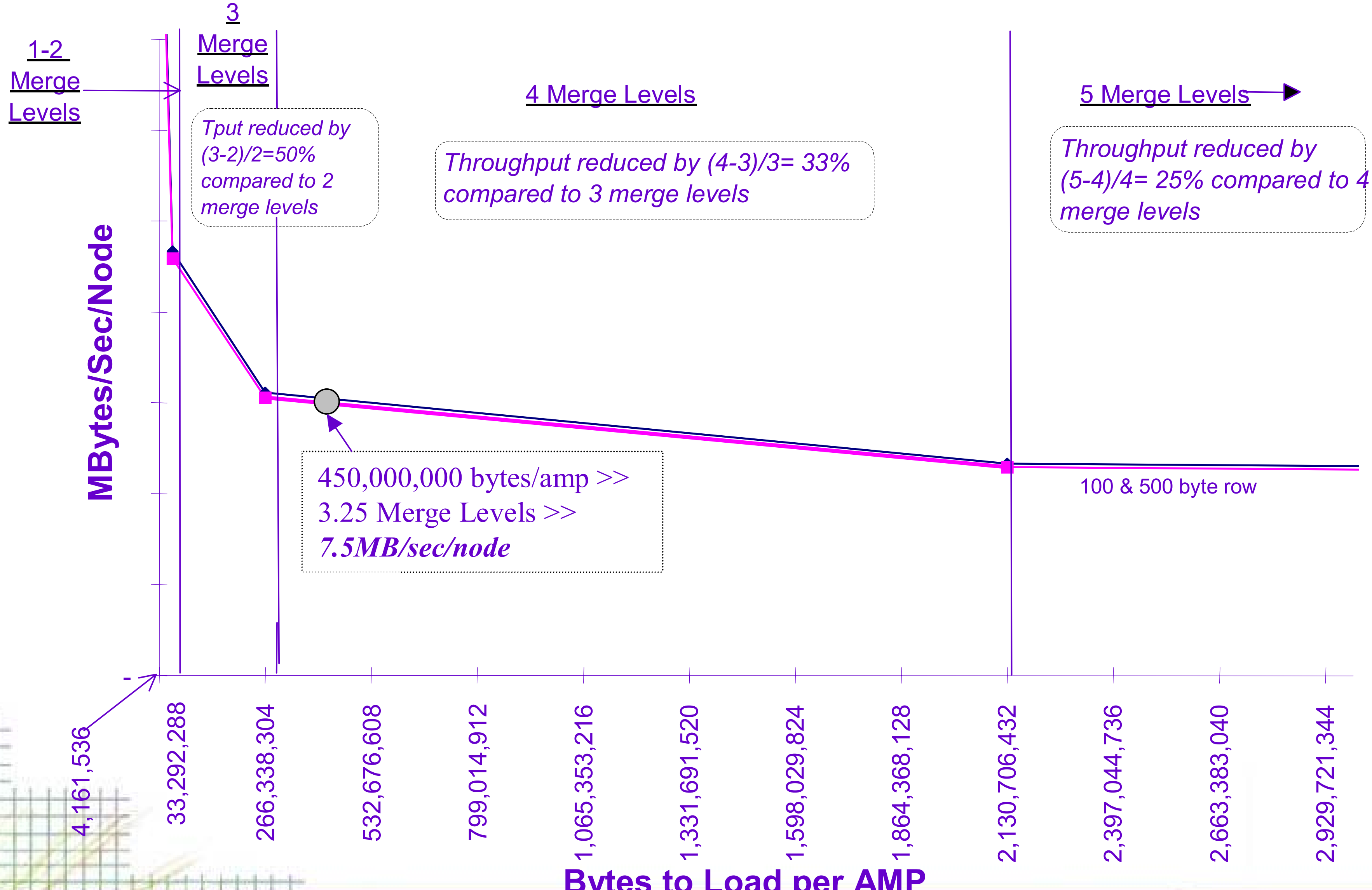
FastLoad Apply

- **Apply Functionality:**
  - Each AMP performs 8-way merge-sorts on its buffers.
  - Writes the sorted data to disk.
- Performance trend dependent on number of 8-way merge-sorts that must be performed.
  - Our Merge-level is 3.25
  - Determining your merge-sort level
    - Merge-level = $\log_8$(Kbytes/AMP / 508KBytes)



$$\text{Apply Time} = \frac{\text{(Mbytes to load/node)}}{\text{(7.5 Mbytes/sec/node)}} * \frac{\text{Your Merge Level}}{3.25}$$

FastLoad Apply - Merge Level Effects

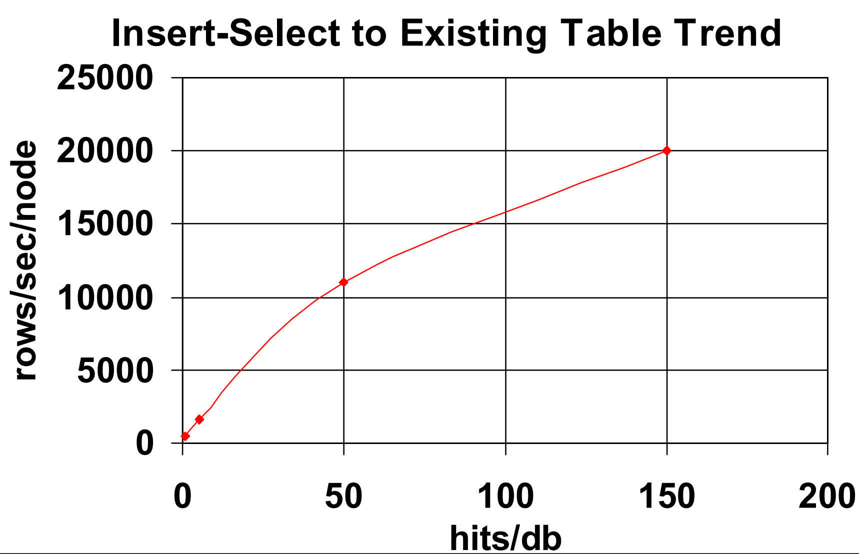


Complex Full File Updates - Apply

- **Primary table modifications done block at a time.**
- Performance trend depends on number of rows/DB affected.
  - Tput increases as rows/db increase to a peak rate.*

Apply Time = *Query time* + *(Rows to update/node)* / *(rows/sec/node rate for your hits/db)*

Multiply Time by 2.4x if fallback.




```
INSERT into  tablexxx SELECT * FROM table2xxx
WHERE <some rows qualify and PI of both tables is same, (no redistribution)>;
```

* Processing time accumulates mostly ‘per row’ and ‘per datablock’, not ‘per byte’.

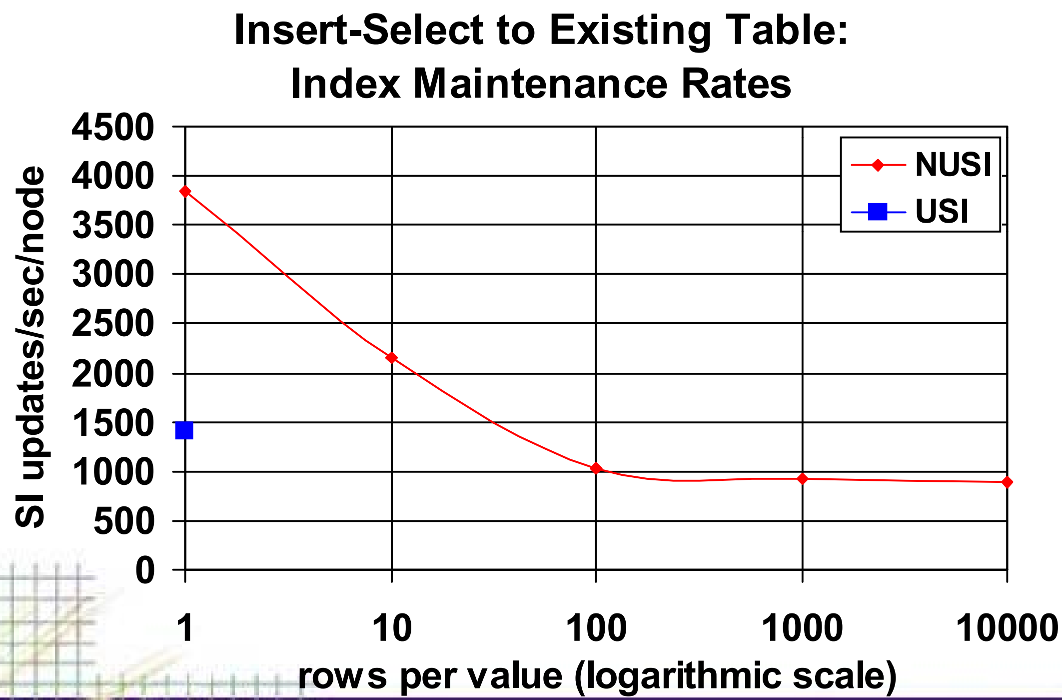
* Datablock size has some impact on throughput rates.

- Larger datablocks greatly improve the total response time of an update, but not fully by the corresponding increase in hits/datablock it results in. ‘Per datablock’ processing time is larger with larger datablocks than it is with smaller datablocks.

Complex Full File Updates - Indexes

- **For Full File <u>Updates</u>: Usually No Index Management required.**
- **Full File <u>Inserts</u> and <u>Deletes</u>: Secondary Index modifications done row-at-a-time.**
  - Its better to drop and recreate the index unless the number of rows to update are *<u>very small</u>*, ie:

    <= 0.1% of the table's rows being updated



For each SI: ***SI_time =***

<u>(# of rows to update/node)</u>

(rows/sec/node rate)

Multiply Time by 2.4x if fallback.

MultiLoad, Tpump, Complex Updates - Maximizing Performance of Index Maintenance

- **Do you really get value from that Secondary Index?**
  - Unless value uniqueness is enough so that queries will choose the index to access the table, don't create the index.
    - Will the number of rows qualifying from "Where index = value" result in fewer datablocks being accessed than there are datablocks in the primary table?
    - Index Wizard will tell you if your Secondary Index will be used.
- **Consider Sparse JI**
  - Maintenance only required for a small percentage of the rows
  - Remember, Sparse JI's must be dropped and recreated if you utilize Multiload.
- **Consider drop and recreate secondary indexes**
  - Generally only an option for very infrequent Multiloads or somewhat infrequent Complex Updates

Create Fallback & Indexes

- **Create Fallback:**
  - Redistribute rows to fallback AMP and generate fallback table.

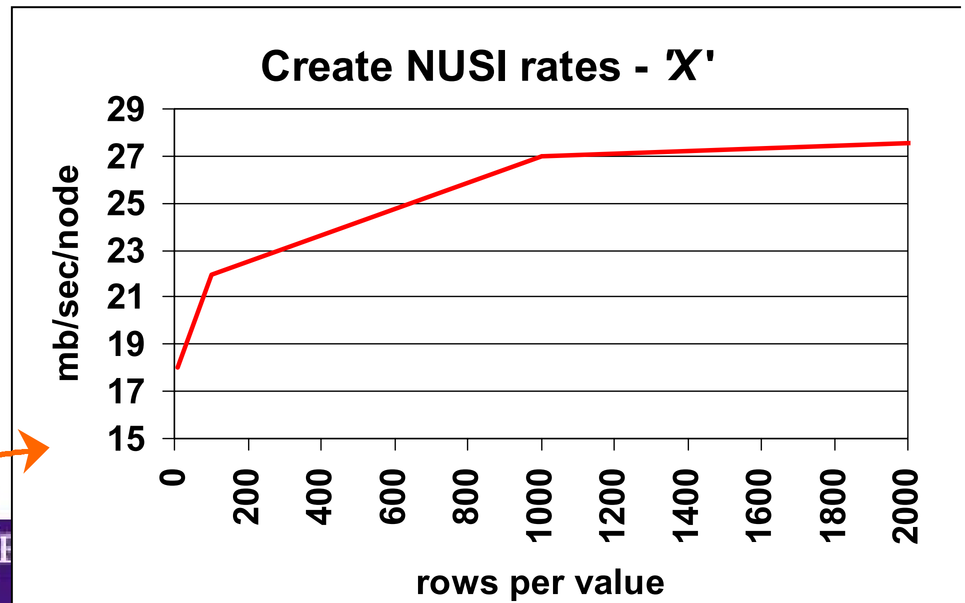
$$\text{Create Fallback Time} = \frac{\textit{(Mbytes to load/node)}}{\textit{(12 Mbytes/sec/node)}}$$

- **Create USI**
  - Primary Copy only -- double time if fallback.

$$\text{Create USI Time} = \frac{\textit{(Mbytes to load/node)}}{\textit{(17 Mbytes/sec/node)}}$$

- **Create NUSI**
  - Primary Copy only -- double time for fallback.

$$\text{Create NUSI Time} = \frac{\textit{(Mbytes to load/node)}}{\textit{(X Mbytes/sec/node)}}$$



A Cross Comparison of Data Load Strategies

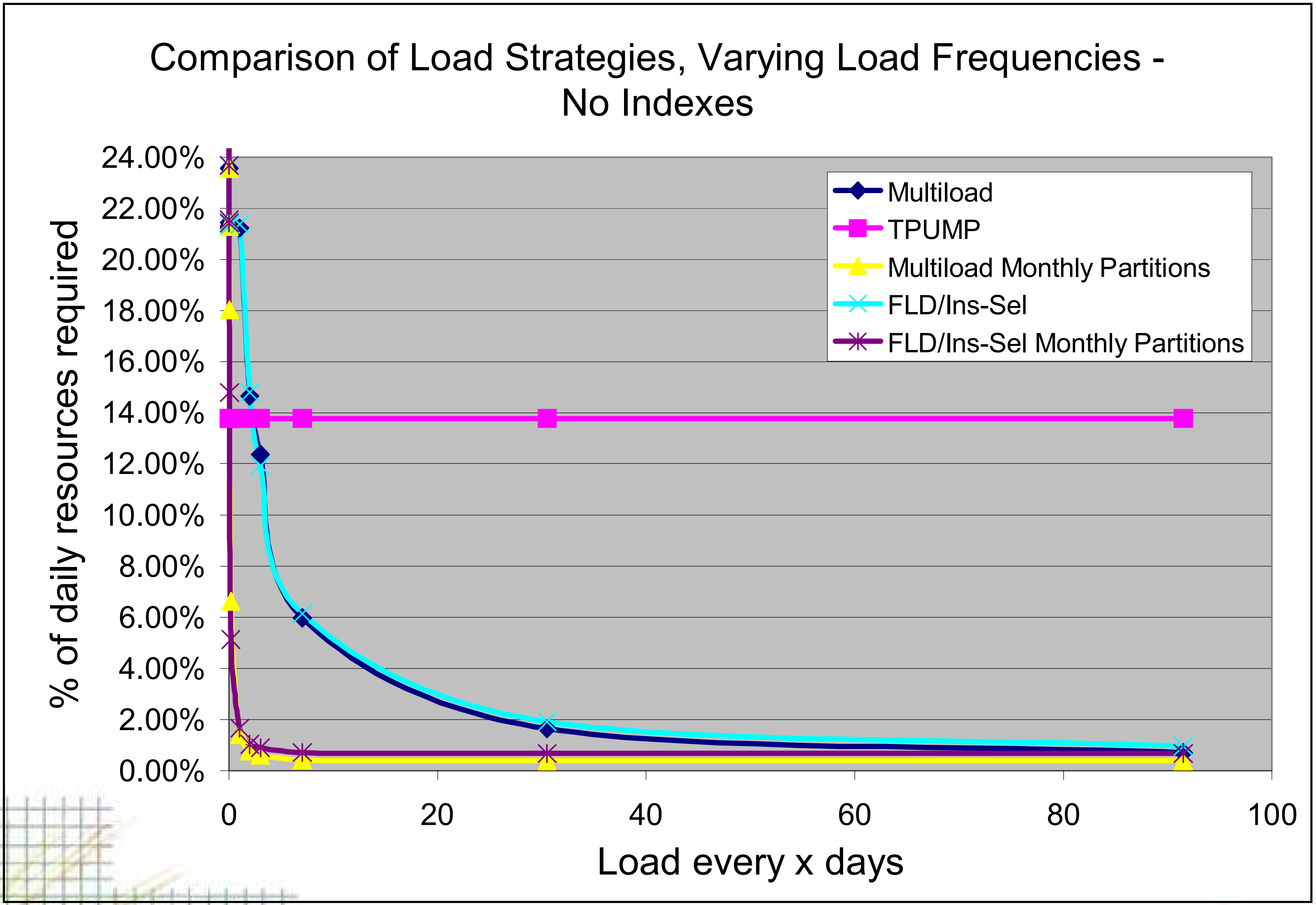
- **Real-Time vs Near Real-Time vs Delayed Availability**
  - TPump: Just trickle them in as you get them.
  - Frequent Batch Fastload/Insert-Select or Multiload every few minutes.
    - With and without PPI.
  - Multiload or Fastload/Insert-Select on daily or weekly intervals

- **Scenario:**
  - 3 years x 5 mil rows a day, 100 byte rows
  - No Secondary Indexes
  - No Fallback, No Permanent Journal
  - No Transformation / Cleansing
  - No Client / Connectivity Bottlenecks

At varying load frequencies, how does performance of TPUMP vs Multiload vs Fastload / Insert-Select compare?

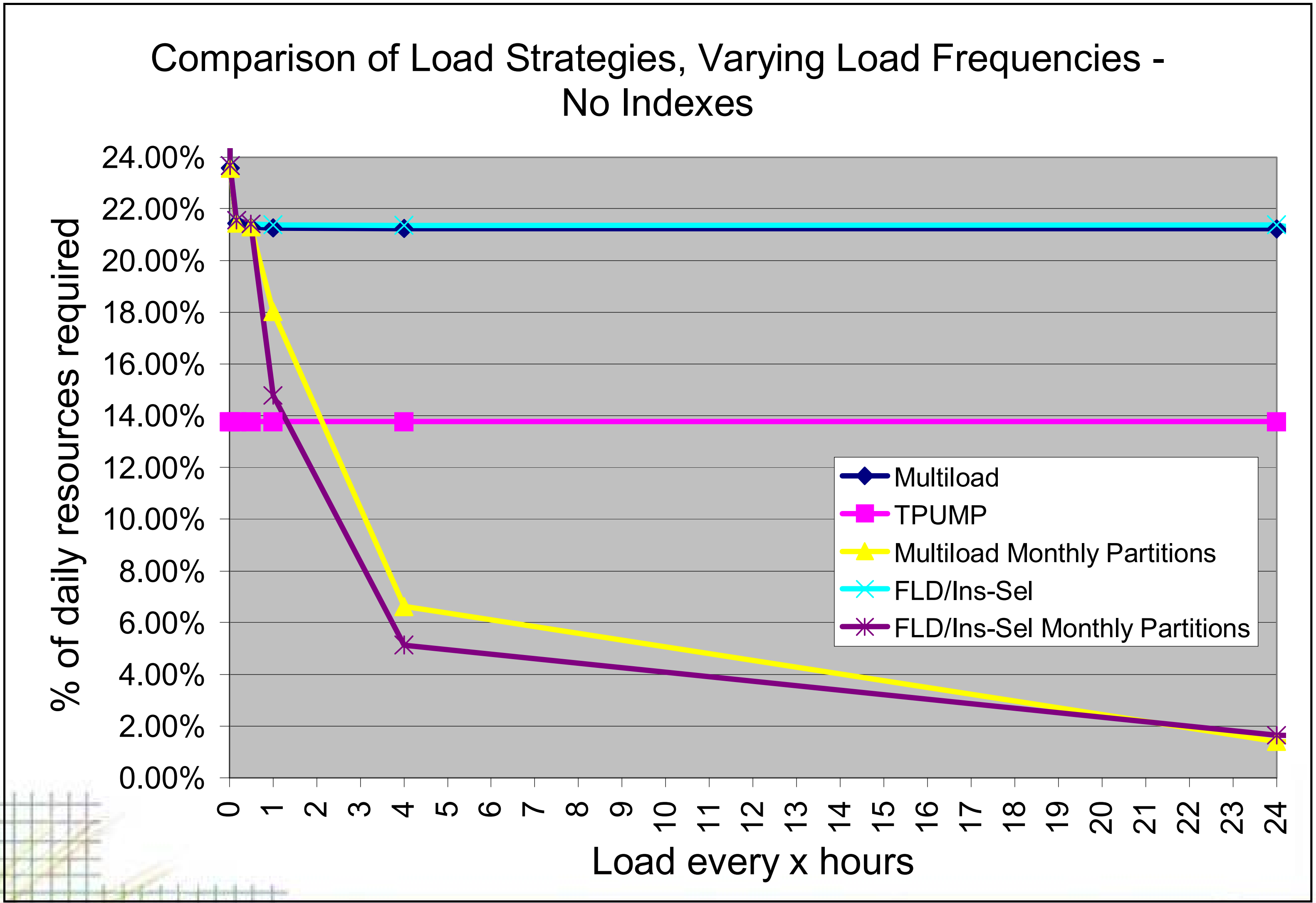
Much Delayed Availability

① MultiLoad-Partitions ② FastLoad / Ins-Sel - Partitions ③ MultiLoad ④ FastLoad / Ins-Sel ⑤ TPump



Delayed Availability

① FastLoad / Ins-Sel - Partitions ② Multiload - Partitions ③ TPump ④ MultiLoad ⑤ FastLoad / Ins-Sel



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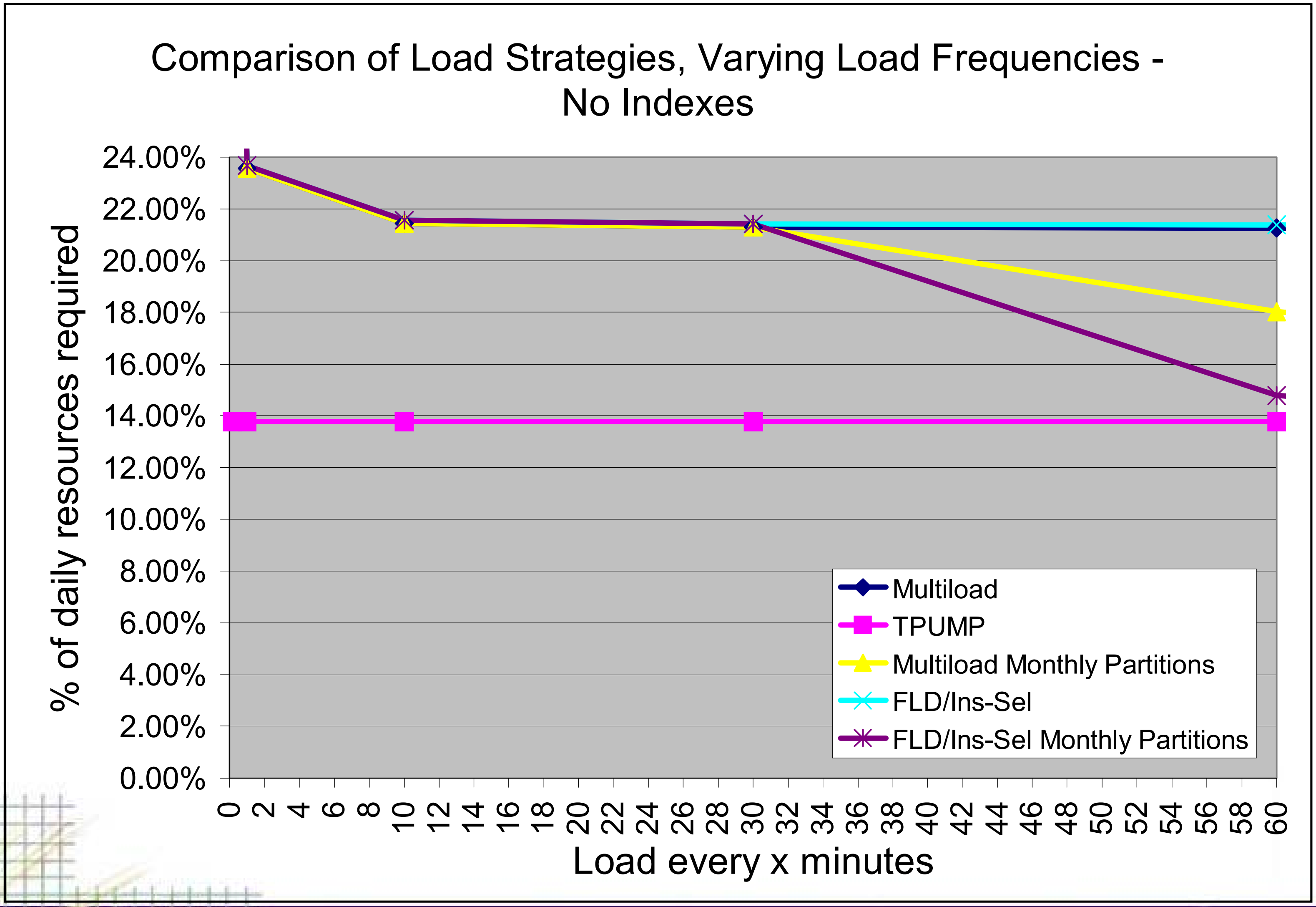
Real-Time and Near Real-Time Availability

① TPump ② FastLoad / Ins-Sel - Partitions ③ Multiload - Partitions ④ MultiLoad ⑤ FastLoad / Ins-Sel



Q&A