Partitioning
What, When, Why & How

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Who am I

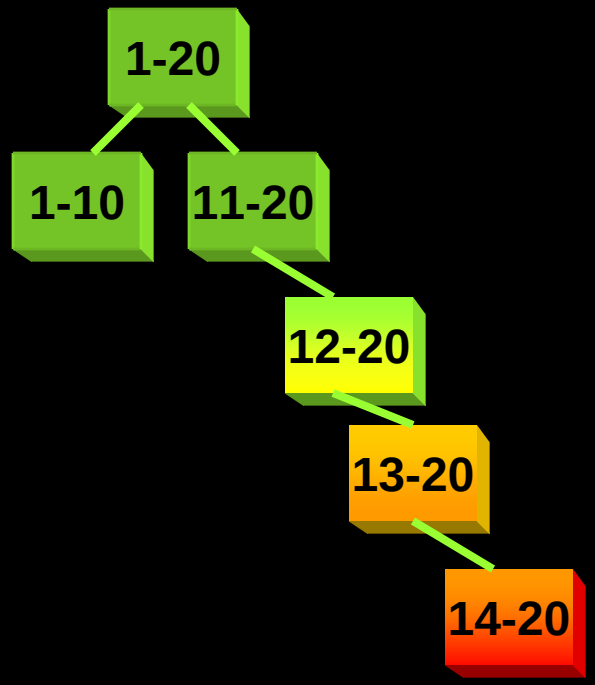
- Oracle DBA for 14 years and counting
- Speak at conferences, write articles, 4 books
- Brought up the Global Database Group at Starwood Hotels, in White Plains, NY
- Responsible for Architecture, Strategy and Engineering
- Assist in Operations

About this Session

- This is not an introduction to partitioning
  - Will not cover syntax
- **What** type of partitioning
- **When** to use partitioning
- **Why** partition something
- **How** to use partitioning to overcome common challenges
- Caveats and traps to watch out for
- A complete case study to show how decisions are made

Index Blocks Too Hot to Handle

- Consider an index on TRANS_ID – a monotonically increasing number
- It may make a handful of leaf blocks experience severe contention
- This hot area shifts as the access patterns change
- Solution: Reverse Key Index?



Hash Partitioned Index

- Index Can be hash-partitioned, regardless of the partitioning status of the table

```
create index IDX_TRANS_1 on TRANS (TRANS_ID) global
partition by hash (RES_ID)
partitions 8
```

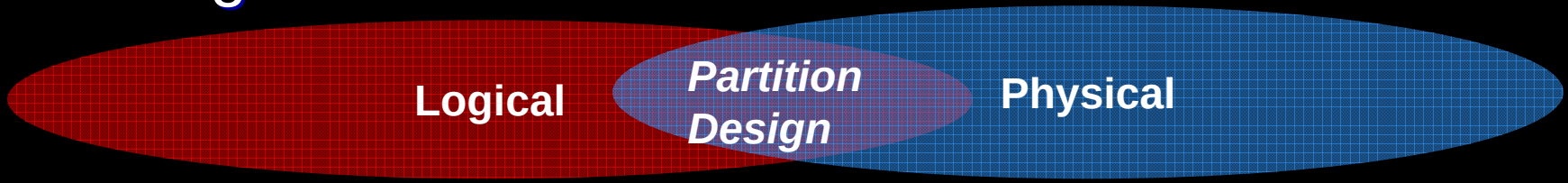
- Table TRANS is un-partitioned; while index is partitioned.
- This creates multiple segments for the same index, forcing index blocks to be spread on many branches.
- Can be rebuilt:

```
alter index IN_RES_01 rebuild partition <PartName>;
```

- Can be moved, renamed, etc.

When

- Overlap between Logical Modeling and Physical Design



- Last part of logical design and first part of physical design
- When should partitioning be used
  - In almost all the time for large tables
- There is no advantage in partitioning small tables, right?
  - Wrong. In some cases small tables benefit too

Why? Common Reasons

- Easier Administration:
  - Smaller chunks are more manageable
  - Rebuilding indexes partition-by-partition
  - Data updates, does not need counters
- Performance:
  - full table scans are actually partition scans
  - Partitions can be joined to other partitions
  - Latching

More Important Causes

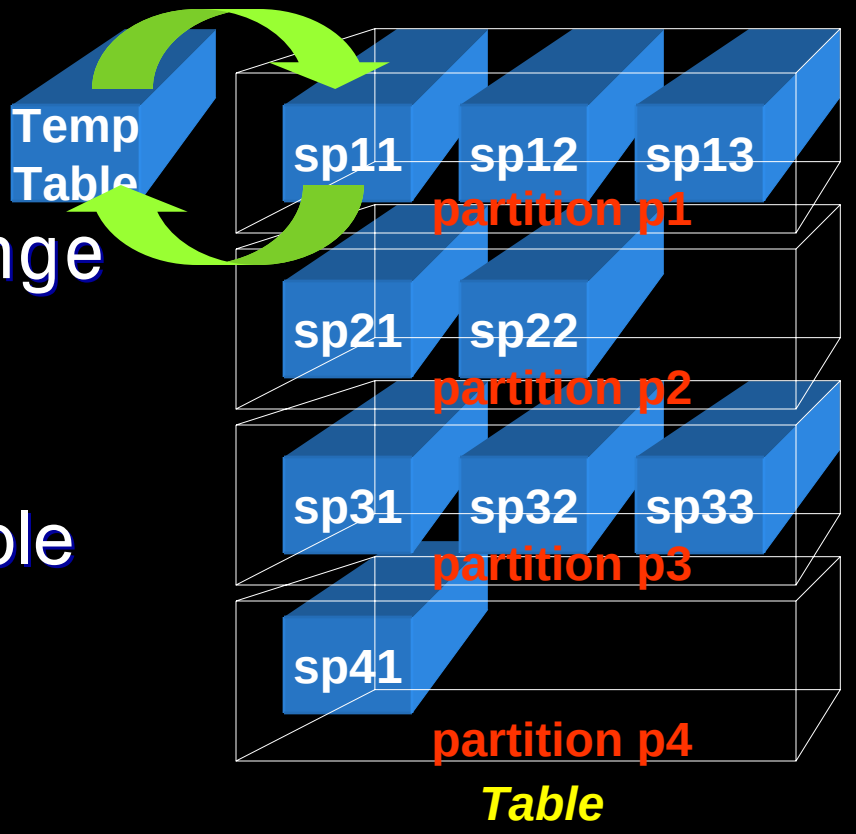
- Data Purging
  - DELETEs are expensive – REDO and UNDO
  - Partition drops are practically free
  - Local indexes need not be rebuilt
- Archival
  - Usual approach: insert into archival table select * from main table
  - Partition exchange
  - Local indexes need not be rebuilt

Materialized Views Refreshes

- Partition Exchange
  - Create a temp table
  - Create Indexes, etc.
  - When done, issue:

```
alter table T1 exchange
  partition sp11 with
  table tmp1;
```

  - Data in TMP1 is available



Backup Efficiency

- When a tablespace is read-only, it does not change and needs only one backup
  - RMAN can skip it in backup
  - Very useful in DW databases
  - Reduces CPU cycles and disk space
- A tablespace can be read only when all partitions in them can be so

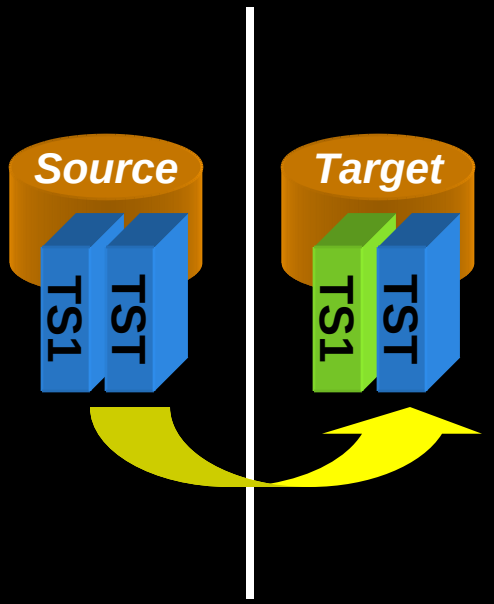
```
SQL> alter tablespace Y08M09 read only;
```

Data Transfer

- Traditional Approach

```
insert into target select
  * from source@dblink
```

- Transportable Tablespace
  - Make it read only
  - Copy the file
  - "Plug in" the file as a new tablespace into the target database
  - Can also be cross-platform



Information Lifecycle Management

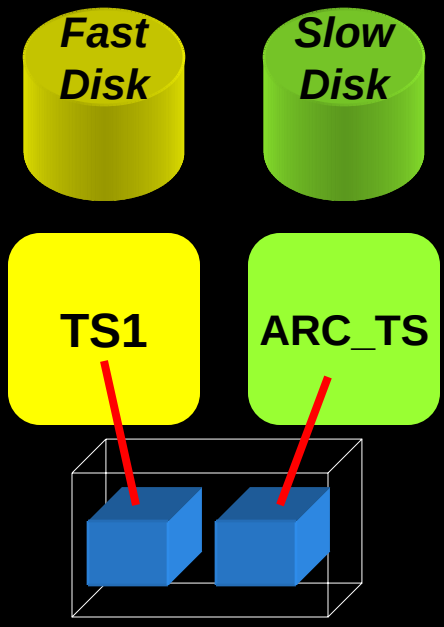
- When data is accessed less frequently, that can be moved to a slower and cheaper storage, e.g. from DMX to SATA
- Two options:
  1. Create a tablespace ARC_TS on cheaper disks

     ```
     ALTER TABLE TableName MOVE
       PARTITION Y07M08
       TABLESPACE ARC_TS;
     ```

     Reads will be allowed; but not writes
  2. ASM Approach

     ```
     ALTER DISKGROUP DROP DISK …
       ADD DISK …
     ```

     Fully available



How to Decide

- First, decide on the objectives of partitioning. Multiple objectives possible
- Objectives
  - Data Purging
  - Data Archival
  - Performance
  - Improving Backups
  - Data Movement
  - Ease of Administration
  - Different Type of Storage

Assign priorities to each of these objectives

Global-vs-Local Index

- Whenever possible, use local index
- In Primary Key (or Unique) Indexes:
  - If part column is a part of the PK – local is possible and should be used
  - e.g. RES table. PK – (RES_DT, RES_ID) and part key is (RES_DT)
- If not, try to include the column in PKs
  - E.g. if RES_ID was the PK of RES, can you make it (RES_DT, RES_ID)?
- Ask some hard design questions
  - Do you really need a PK constraint in the DW?

Case Study

- Large Hotel Company
- Fictitious; any resemblance to real or fictional entities is purely coincidental

Background

- Hotel reservations made for *future* dates
- When guests check out, the CHECKOUTS table is populated
- RESERVATIONS has RES_DT
  - is always in future (up to three years)
- CHECKOUTS has CK_DT
  - is always present or past.

Thought Process

- Q: How will the tables be purged?
- A: Reservations are deleted 3 months after they are past. They are *not* deleted when cancelled.
  - Checkouts are deleted after 18 months.
- Decision:
  - Since the deletion strategy is based on time, Range Partitioning is the choice with one partition per month.

Column

- Since deletion is based on RES_DT and CK_DT, those columns were chosen as partitioning key for the respective tables
- Scripts:

```
create table reservations (…)
partition by range (res_dt) (
    partition Y08M02 values less than
  (to_date('2008-03-01','yyyy-mm-dd')),
    partition PMAX values less than
  (MAXVALUE)
)
```

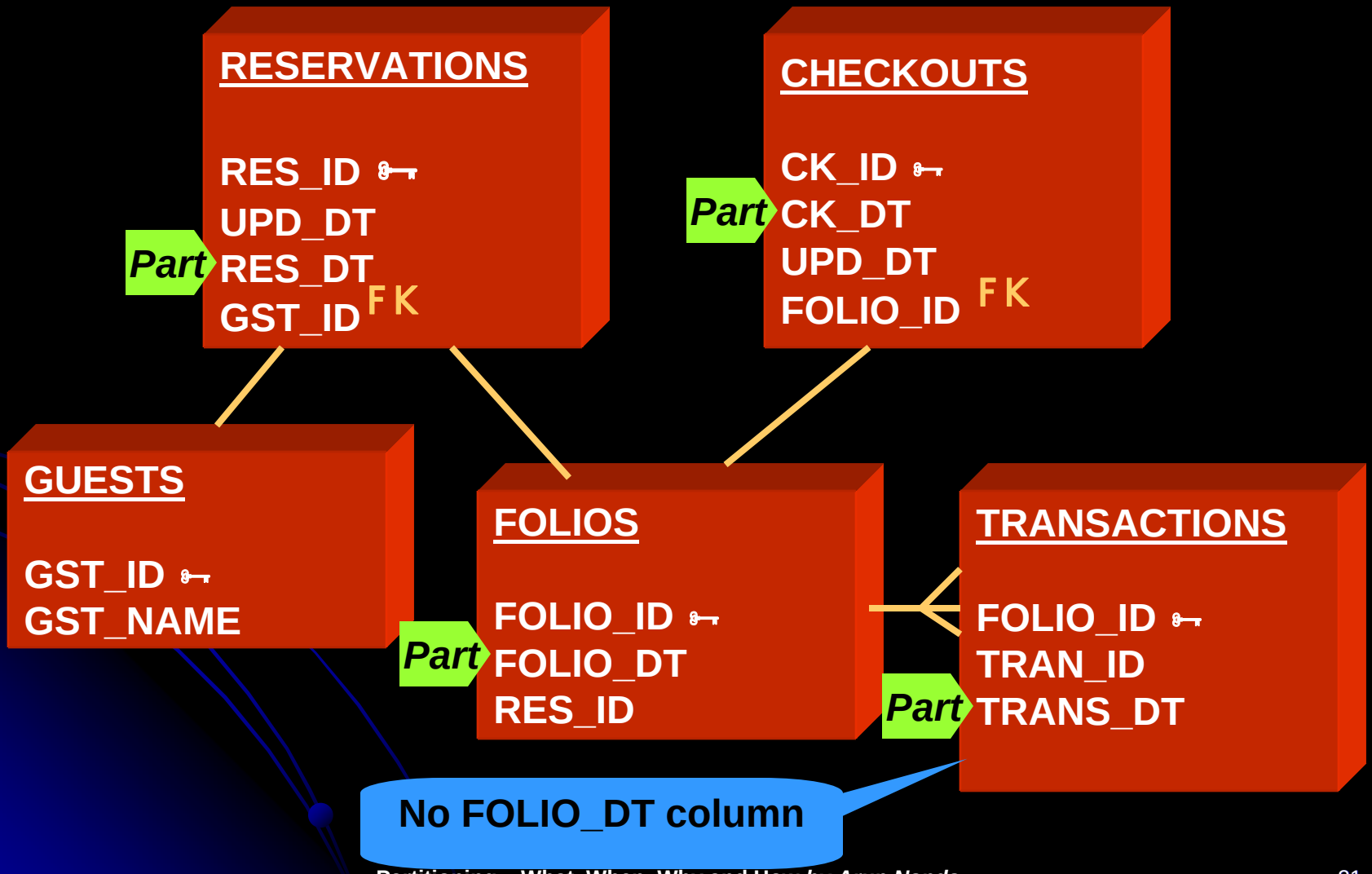
Access Patterns

- Q: Will checkouts within last 18 months be *uniformly* accessed?
  - A: No. Data <= 3 months is heavily accessed. 4-9 months is light; 9+ is rarely accessed.
- Decision:
  - Use Information Lifecycle Management to save storage cost.

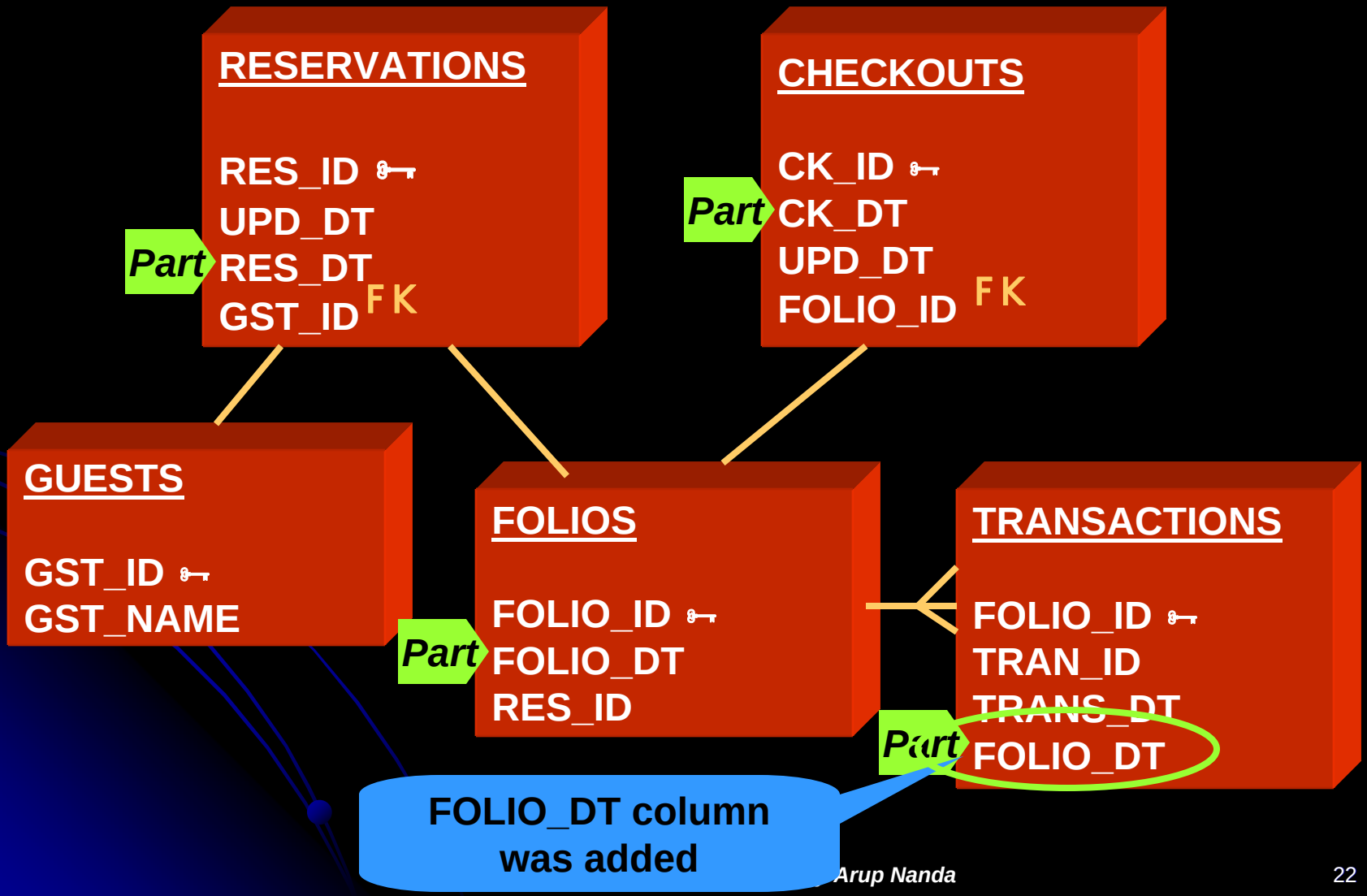
Access Types

- Q: Is it possible that data in past months can change?
  - A: Yes, within 3 months to make adjustments.
- Q: How likely that it will change?
  - A: Infrequent; but it does happen. 3+ months: not possible to change.
- Q: How about Reservations?
  - A: They can change any time for the future.
- Decision: Make partitions read only.

Partitioning 1st Pass



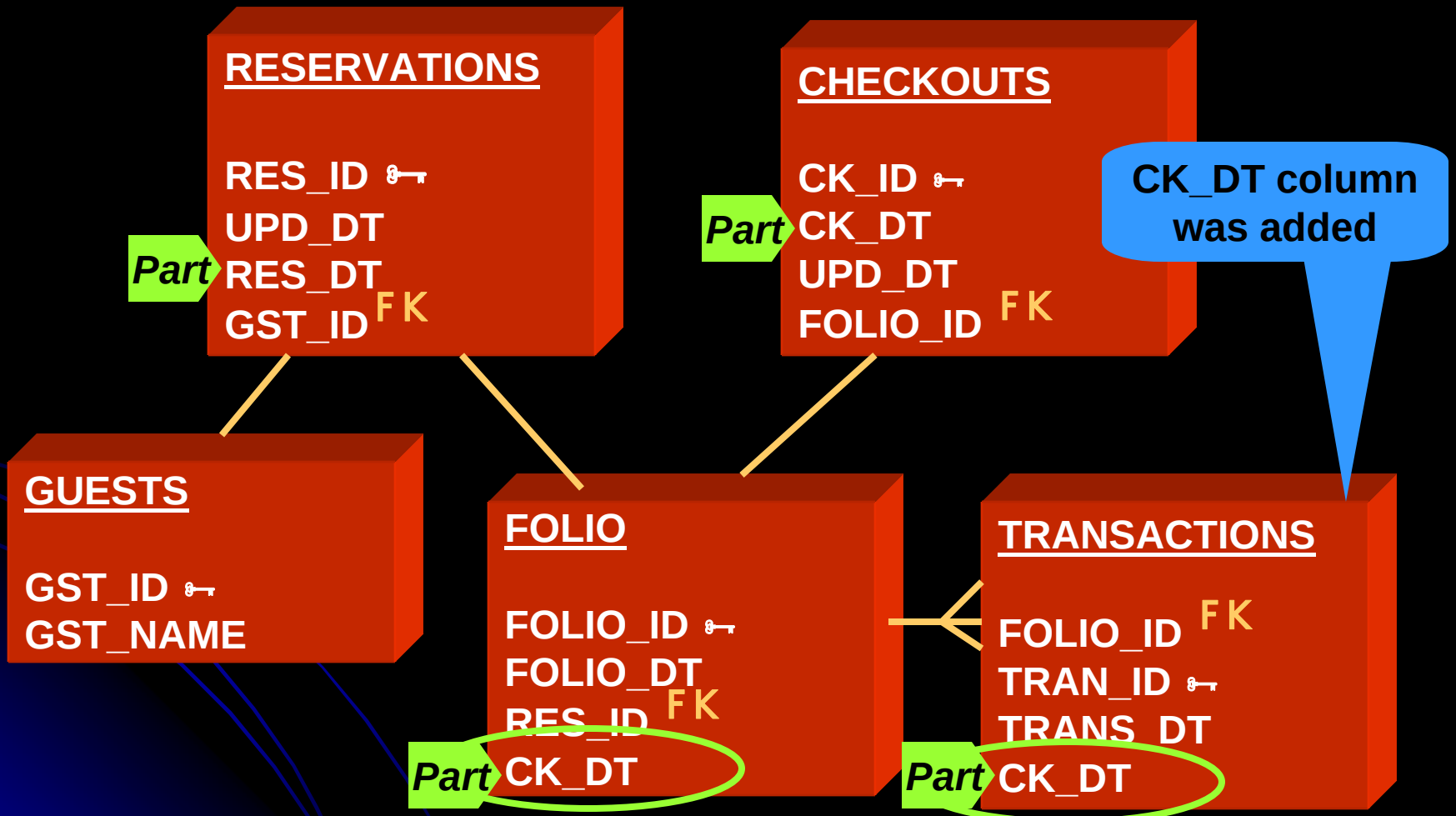
Column Add for Partitioning



Problem

- Purge on CHECKOUTS, FOLIOS and TRANSACTIONS is based on CK_DT, not FOLIO_DT
- FOLIO_DT is the date of creation of the record; CK_DT is updated date
- The difference could be months; so, purging can't be done on FOLIO_DT
- Solution: Partitioning Key = CK_DT
- Add CK_DT to other tables

2nd Pass


RESERVATIONS
RES_ID
UPD_DT
Part
RES_DT
GST_ID
FK
CHECKOUTS
CK_ID
Part
CK_DT
UPD_DT
FOLIO_ID
FK
CK_DT column was added
GUESTS
GST_ID
GST_NAME
FOLIO
FOLIO_ID
FOLIO_DT
FK
Part
CK_DT
TRANSACTIONS
FOLIO_ID
FK
TRAN_ID
Part
CK_DT

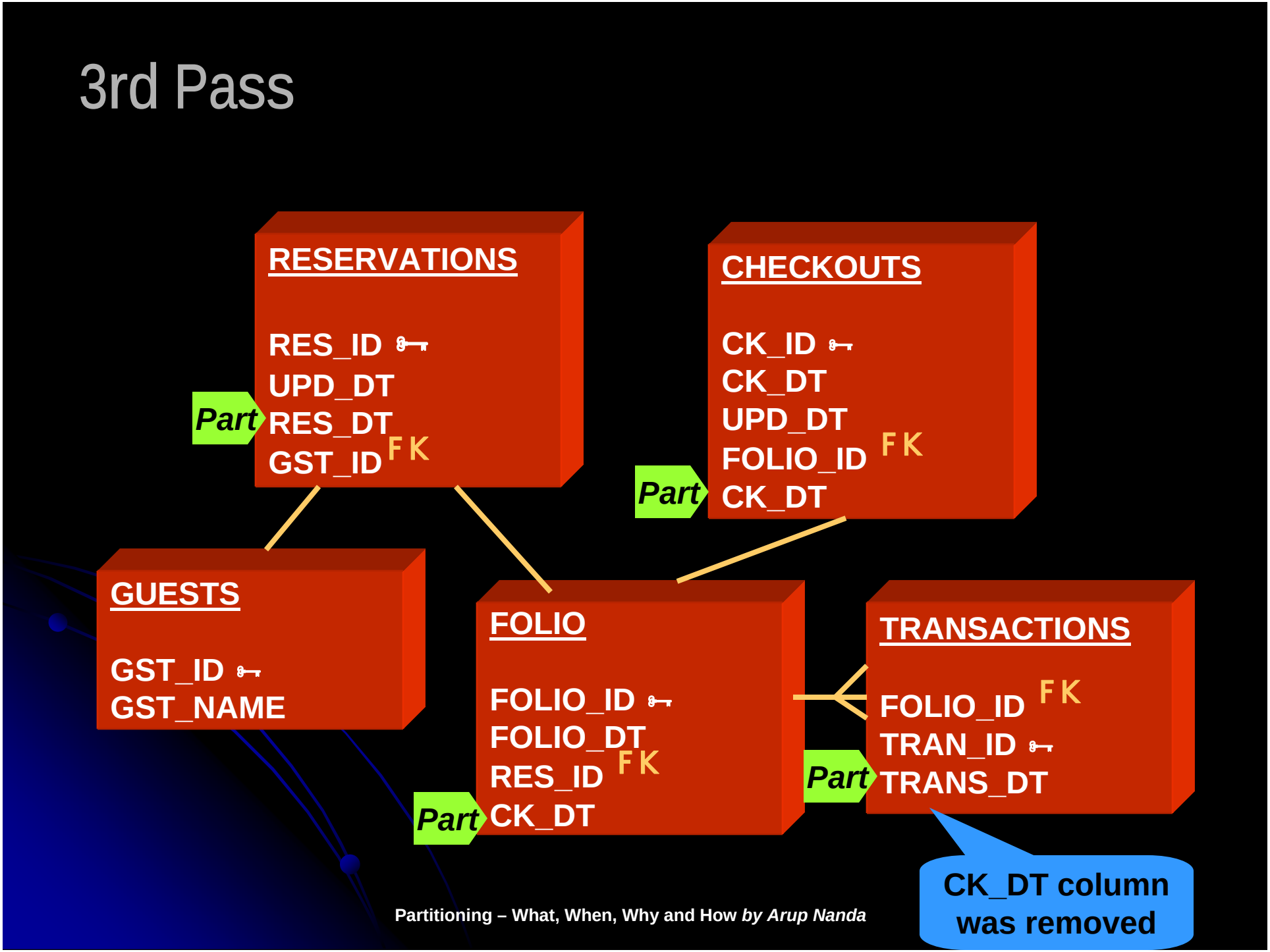
Problems after 2nd Pass

- #1 FOLIOS records created at Check-in
  - CK_DT is updated at Check-out; the record may move to a different partition
  - Decision = Acceptable
- #2 CK_DT will not be known at Check-in; so value will be NULL. Which partition?
  - Decision = not NULL; set to tentative date
  - against Relational Database Puritan Design

Problems, cont..

- #3: TRANS table may have many rows; updating CK_DT may impact negatively
  - Decision: Remove CK_DT from TRANS
  - Partition on TRANS_DT
  - Fact: TRANS_DT <= CK_DT
  - So, when partition SEP08 of CHECKOUTS is dropped, SEP08 partition of TRANSACTIONS can be dropped too
  - Just because part columns are different, purge does not have to different.

3rd Pass


RESERVATIONS
RES_ID
UPD_DT
Part
RES_DT
GST_ID
FK
CHECKOUTS
CK_ID
CK_DT
UPD_DT
FOLIO_ID
FK
Part
CK_DT
GUESTS
GST_ID
GST_NAME
FOLIO
FOLIO_ID
FOLIO_DT
RES_ID
FK
Part
CK_DT
TRANSACTIONS
FOLIO_ID
FK
TRAN_ID
Part
TRANS_DT
CK_DT column was removed

Scenario #1

- Reservation made on Aug 31st for Sep 30th checking out tentatively on Oct 1st
  - Records Created:

Table	Part Key	UPD_DT	Partition
RESERVATIONS	09/30	08/31	SEP08

- Guest checks in on 9/30

FOLIOS	10/01	09/30	OCT08

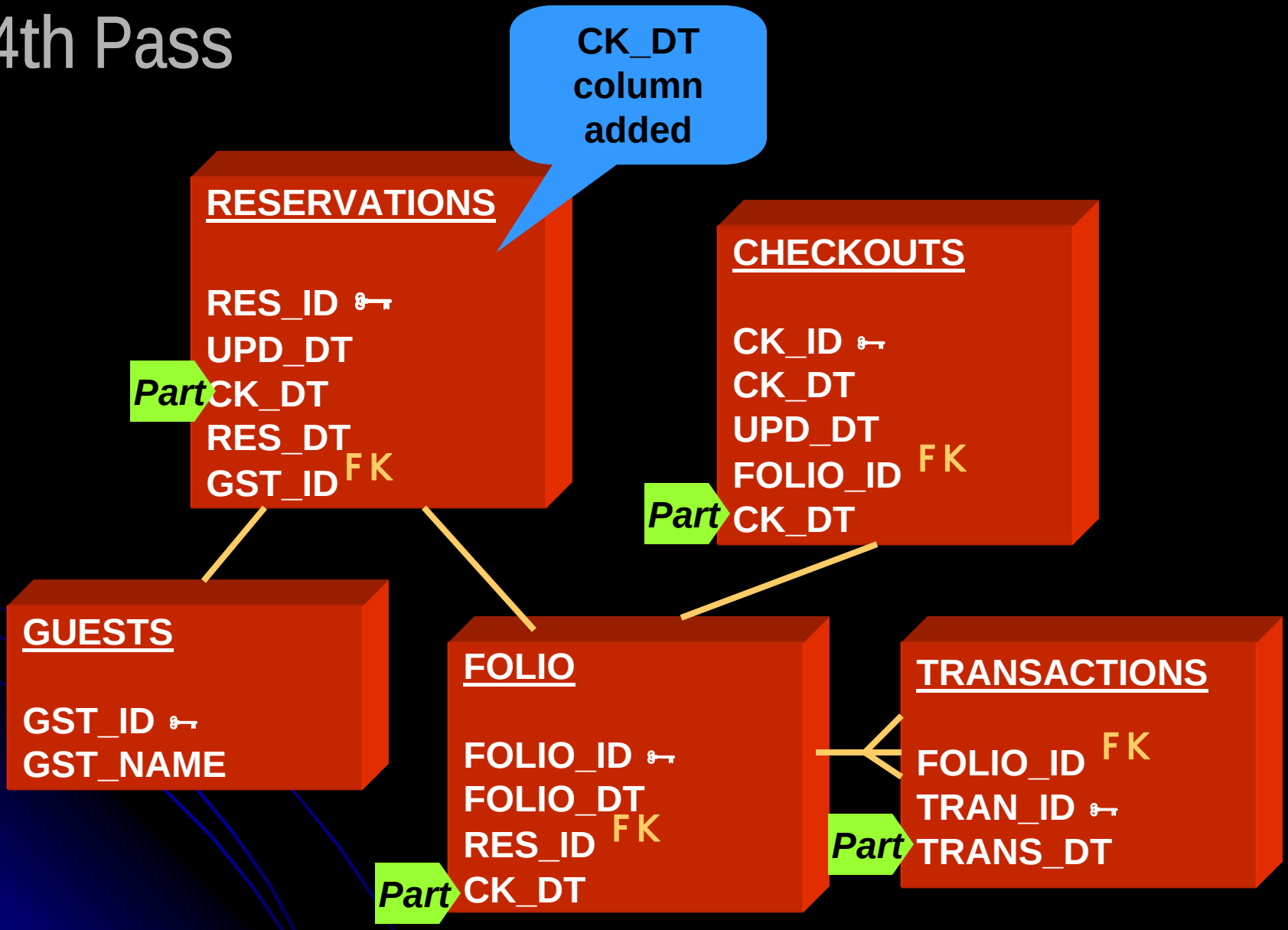
- Checks out on Oct 2nd:

CHECKOUTS	10/02	10/02	OCT08
TRANSACTIONS	10/02	10/02	OCT08

CK_DT in RES?

- New Thought:
  - Why not partition RESERVATIONS table by CK_DT as well?
- CK_DT column not present in RES
  - But can be calculated; since we know the number of days of stay.
- Tentative Checkout Date column added

4th Pass


CK_DT column added
RESERVATIONS
RES_ID
UPD_DT
Part CK_DT
RES_DT
GST_ID FK
CHECKOUTS
CK_ID
CK_DT
UPD_DT
FOLIO_ID FK
Part CK_DT
GUESTS
GST_ID
GST_NAME
FOLIO
FOLIO_ID
FOLIO_DT
RES_ID FK
Part CK_DT
TRANSACTIONS
FOLIO_ID FK
TRAN_ID
Part TRANS_DT

Scenario #1 Modified

- Reservation made on Aug 31st for Sep 30th checking out tentatively on Oct 1st
  - Records Created:

Table	Part Key	UPD_DT	Partition	
RESERVATIONS	10/01	08/31	OCT08	New record

- Guest checks in on 9/30

FOLIOS	10/01	09/30	OCT08	New record

- Checks out on Oct 2nd:

CHECKOUTS	10/02	10/02	OCT08	New record
TRANSACTIONS	10/02	10/02	OCT08	
RESERVATIONS	10/02	10/02	OCT08	Update

Scenario #2

- Guest checks out on Nov 1st, instead of Oct 1st:
  - Records Created:

Table	Part Key	UPD_DT	Partition	
RESERVATIONS	10/01	08/31	OCT08	New record
FOLIOS	10/01	09/30	OCT08	New record
CHECKOUTS	11/01	11/01	NOV08	New record
TRANSACTIONS	11/01	11/01	NOV08	
RESERVATIONS	11/01	11/01	NOV08	Row Migration
FOLIOS	11/01	11/01	NOV08	Row Migration

- Guest checks in on 9/30
- Checks out on Nov 1st:

New Column for Partitioning

- Added a column CK_DT
- Two Options for Populating:
  - Apps populate it (possible since this is still in design)
    - Apps will have to change
    - Guaranteed logic
  - Triggers populate (retrofitting partitioning after the apps are written)
    - No change to apps
    - No guarantee of logic

11g Reference Partitions

- No need to have a new column
- Partitions are defined on Foreign Keys, which follow the parent's partitioning scheme.
- One of the most useful innovations in 11g

```
create table trans (
  trans_id number not null,
  folio_id number not null,
  trans_date date not null,
  amt        number,
  constraint fk_trans_01
    foreign key (folio_id)
    references folios
)
partition by reference
   (fk_trans_01);
```

Non-Range Cases

- GUESTS table is unique:
  - 500 million+ records
  - No purge requirement
  - No logical grouping of data. GUEST_ID is just a meaningless number
  - All dependent tables are accessed concurrently, e.g. GUESTS and ADDRESSES are joined by GUEST_ID
- No meaningful range partitions possible

Hash Partitions

- GUESTS table is hash partitioned on GUEST_ID
- Number of Parts: in such a way that each partition holds 2 million records
- Number of partitions must be a power of 2. So 256 was chosen.
- All dependent tables like ADDRESSES were also partitioned by hash (guest_id)

Hotels Tables

- HOTELS table holds the names of the hotels
- Several dependent tables exist – DESCRIPTIONS, AMENITIES, etc. – all joined to HOTELS by HOTEL_ID
- Partitioning by LIST?

Hotels Table Partitioning

- Requirements:
  - Very small
  - No regular purging needs
  - Mostly static; akin to reference data
  - Can't be read only; since programs update them regularly.
- Decision: No partitioning

Tablespace Decisions

- Partitions of a table can go to
  - Individual tablespaces
  - The same tablespace
- How do you decide?
  - Too many tablespaces → too many datafiles → longer checkpoints

Individual Tablespaces

- Tablespaces named in line with partitions, e.g. RES0809 holds partition Y08M09 of RESERVATION table.
- Easy to make the tablespace READ ONLY
- Easy to backup – backup only once
- Easy to ILM

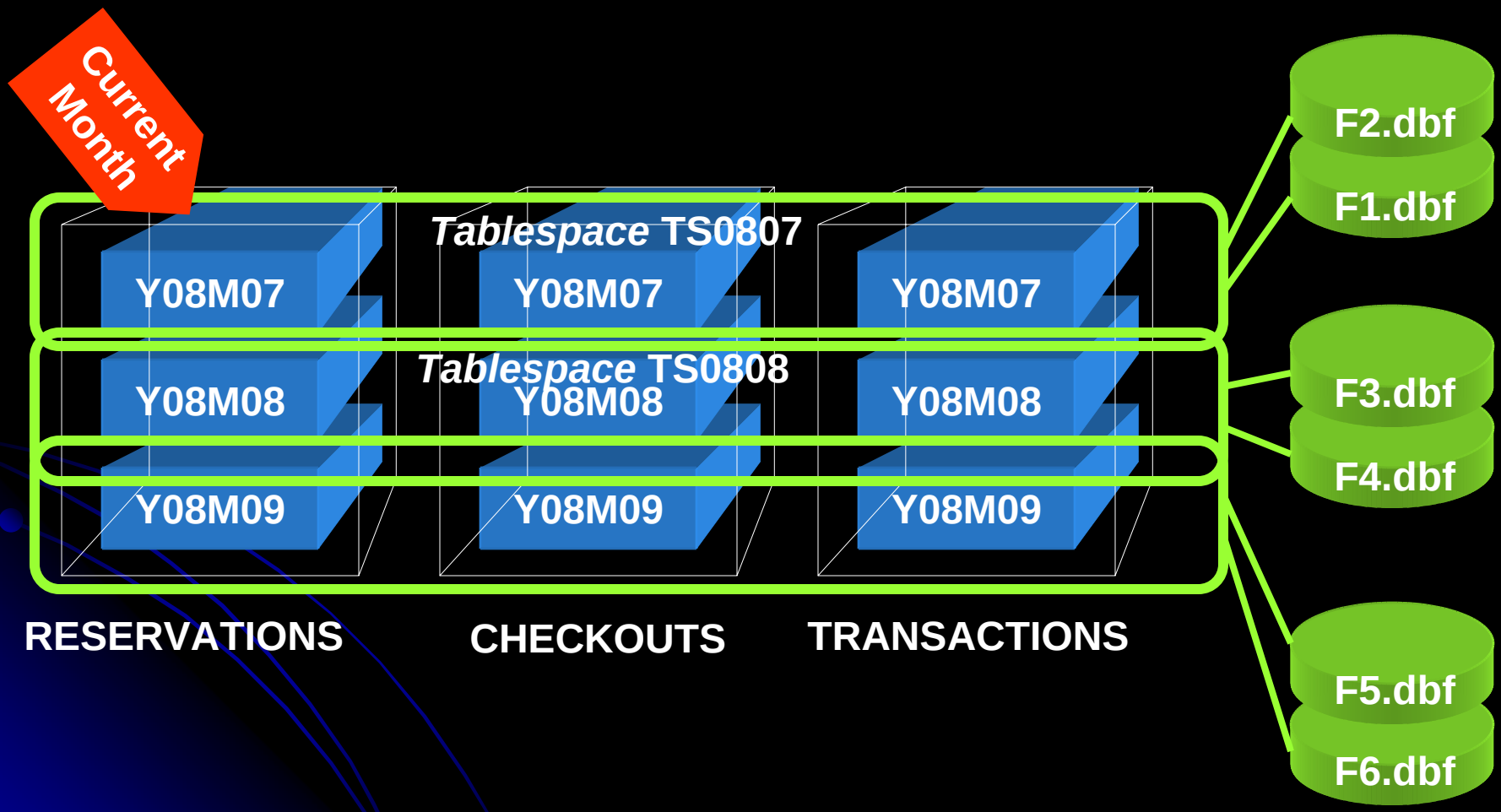
  Move datafiles to lower cost disks

```
ALTER DATABASE DATAFILE
  '/high_cost/…' RENAME TO
  '/low_cost/…';
```

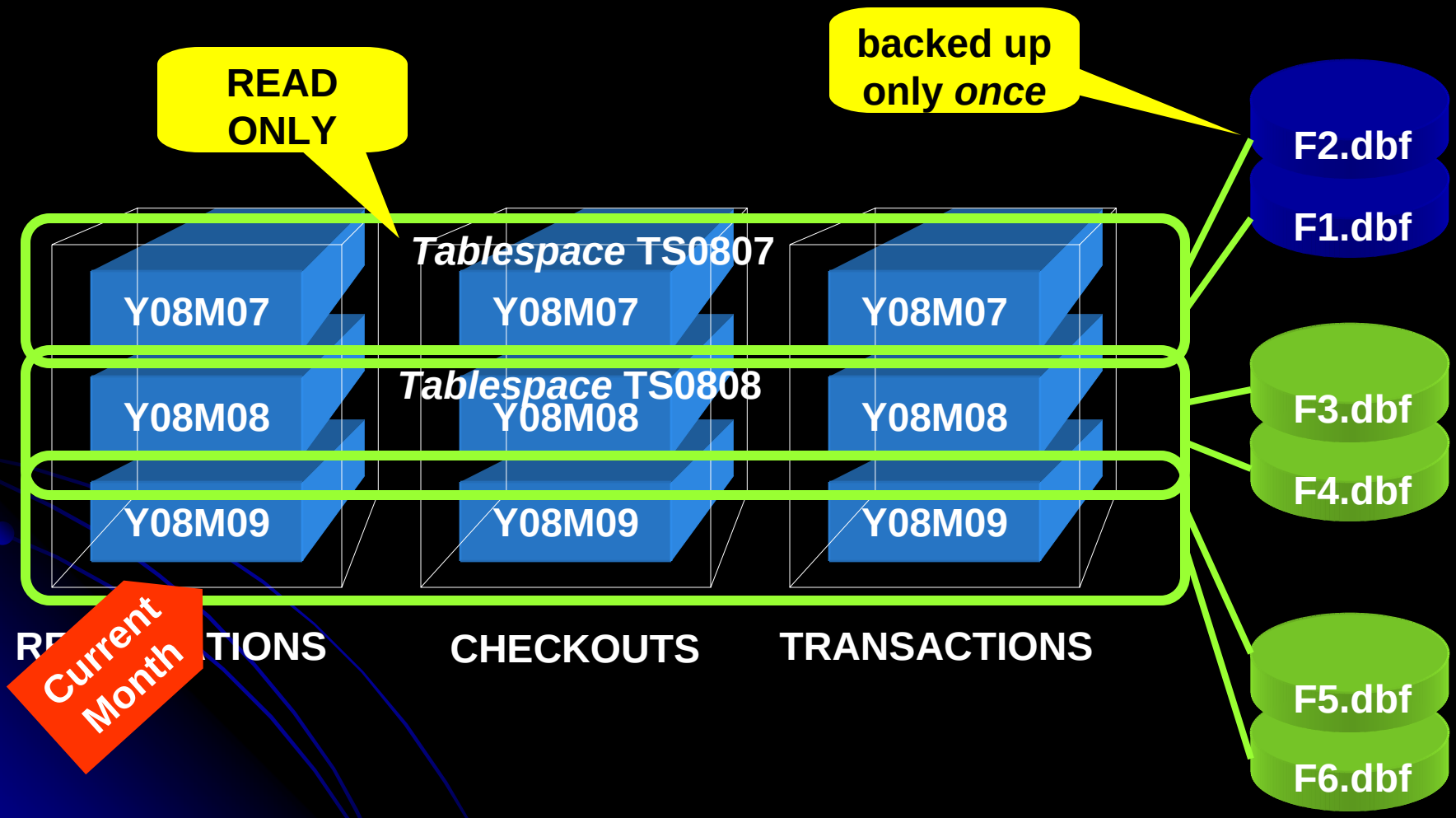
Combined Solution

- Create a tablespace for each period
  - TS0809 for Sep '08
- Contains partitions Y08M09 for all tables – RESERVATIONS, CHECKOUTS, …
- Partitions of the same period for all the tables are usually marked read only
  - If not possible, then this approach fails

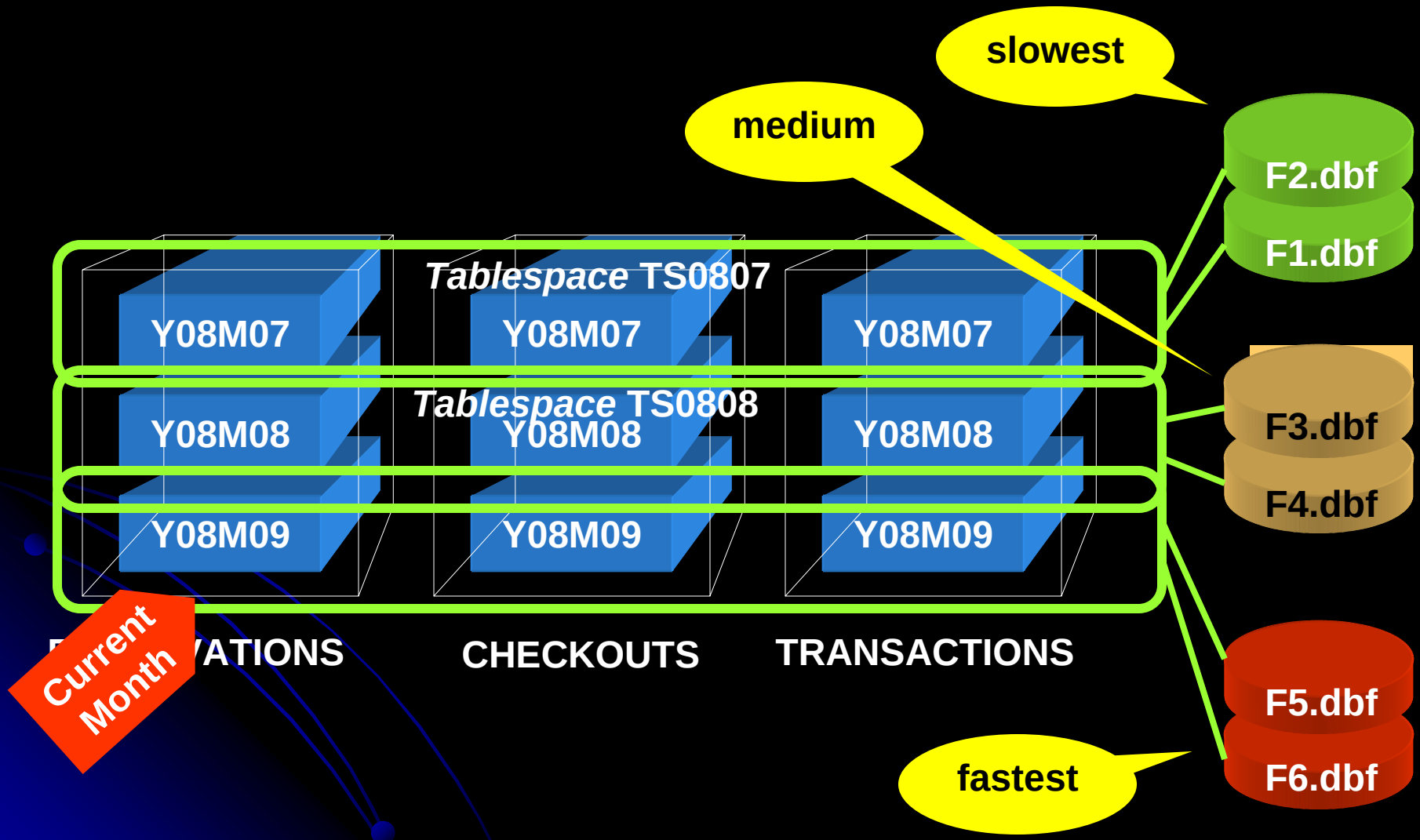
Final Design



Backup


READ ONLY
backed up only *once*
Tablespace TS0807
Y08M07
Y08M07
Y08M07
Tablespace TS0808
Y08M08
Y08M08
Y08M08
Y08M09
Y08M09
Y08M09
Current Month
CHECKOUTS
TRANSACTIONS
F2.dbf
F1.dbf
F3.dbf
F4.dbf
F5.dbf
F6.dbf

ILM


slowest
medium
F2.dbf
F1.dbf
Tablespace TS0807
Y08M07
Y08M07
Y08M07
Tablespace TS0808
Y08M08
Y08M08
Y08M08
F3.dbf
F4.dbf
Y08M09
Y08M09
Y08M09
Current Month
CHECKOUTS
TRANSACTIONS
F5.dbf
F6.dbf
fastest

Partitioning Tips

- List the objectives of partitioning, in the order of priority
- Try to make the same partitioning for all related tables
- Try to introduce new columns
- Avoid Global Indexes

Tips for Choosing Part Key

- Changeable columns do not automatically mean they are not good for part key
- If partition ranges are wide enough, row movement is less likely
- Row movement may not be that terrible, compared to the benefits


Q&A