

A woman with long brown hair, wearing a blue trench coat and blue jeans, is smiling and looking at her smartphone. She is holding several colorful shopping bags (orange, pink, and white) in her left hand. The background is a blurred outdoor setting, possibly a shopping mall or street.

# FORECAST CHALLENGES AND DEMAND CHAIN MANAGEMENT APPROACHES

TERADATA.

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An accurate view of demand can help companies increase sales and decrease inventory costs. Even small improvements in forecast accuracy can result in an impressive return on investment. The Teradata® Demand Chain Management (DCM) solution allows retailers to take advantage of the millions of SKU-locations and time series level detailed data in managing the traditional supply chain. The ability to employ this atomic level data to develop accurate and actionable forecasts down to SKU-location-day level allows the business a more comprehensive view of what it needs to support optimized ordering at any level of the supply chain—including vendors and manufacturers. This is achieved through highly accurate regular/promotional forecasts and integrated replenishment tools. This position paper will describe the basic capabilities of DCM and how it handles the wide variety of product types that must be managed by today’s demand-driven supply chains.

The Teradata DCM Forecast is developed by identifying seasonality, trend, and the irregular component or causals (events).  $\text{Forecast} = \text{Seasonal Factor} \times \text{Best Fit Winning Average Rate of Sale and Adaptive Response} \times \text{Event Uplift}$ . The basic process for calculating the components of this forecast are described here in more detail:

**Seasonality**

Teradata DCM’s Intelligent Profile Clustering module automatically identifies the seasonality for all products based on up to four years of historical sales (if Consumer demand is desired to drive the Supply Chain recommended or shipment/withdrawals if a consumer demand signal is not available). Baseline seasonal profile models are calculated, and then pattern recognition routines and best fit calculations are run to identify unique shapes and automatically assign each stock keeping unit (SKU) to the most appropriate seasonal profile model. The parameters for fit and uniqueness are user defined, and the creation and updating of seasonal profiles is typically done annually. Figure 1 shows two SKUs assigned to a model (dark blue line). The distance between the model and the SKUs is a variance used to help calibrate fit and subsequently an accurate assignment to a seasonal profile.

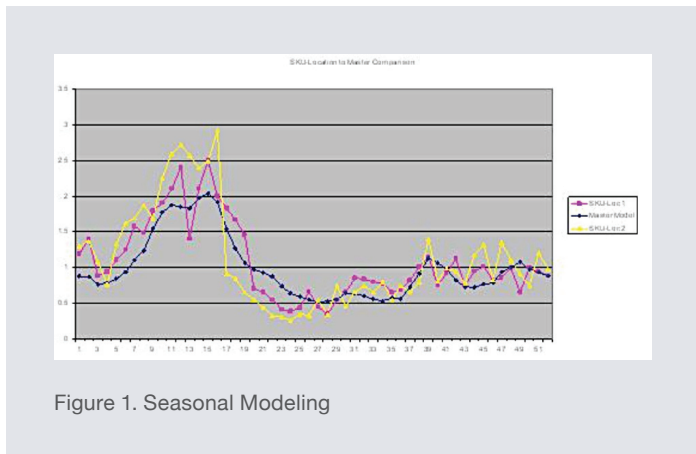


Figure 1. Seasonal Modeling

**Best Fit, Average Rate of Sale Selection**

The solution employs a “best fit selection” of the winning de-seasonalized average-rate-of-sale (ARS) model during each forecast cycle. Each week, the solution will compare the forecast error for each ARS model (3, 6, 12, 26, 52, in addition to 52-week exponential) value to select the ARS with the lowest forecast error. Additionally, the solution will apply slow moving logic to identify very slow moving SKU-location combinations and apply forecast BIAS controls to minimize the negative forecast bias for low-volume SKUs that demonstrate fractional forecasts. A winning ARS will be selected and used along with BIAS control and adaptive response calculations in the new week’s forecast run for each SKU-location combination.

**Note:** the solution can also employ a client-defined ARS within the system if one is desired. The DCM solution can build seasonal models and ARS values free of promotional demand to ensure integrity in these models for regular baseline predictions. Promotional demand is separated by the client or the DCM solution as required.

**Adaptive Response to Trend**

When the winning ARS is selected, DCM executes an adaptive response routine to further correct or fine tune the ARS to be used in the next forecasting cycle. This is accomplished by identifying the level of forecast accuracy and then employing a portion of the winning ARS

ARS Calculations			
Calculation	Forecast	Wins (Last Wk Shown First)	ARS
3 Weeks	8	Y Y N N Y	8.000
6 Weeks	7	N N N N N	7.333
12 Weeks	8	N N N Y N	7.583
26 Weeks	9	N N N N N	8.500
52 Weeks	10	N N N N N	9.596
52 weeks Expo	8	N N Y N N	8.183
Client	9	N N N N N	8.790

Figure 2. ARS Calculations

calculated for the week and the previous ARS in adapting the new ARS to better match the latest trend, improving the forecast results for the next forecast period. The adaptive response or portion of last week’s demand used by the solution in this calculation is user defined, but applied automatically via a business policy. DCM starts by identifying the level of acceptable error and consecutive times the tolerance has been exceeded, based on user-defined tolerances. Typically the blending process starts slowly with 80 percent of last week’s and 20 percent of this week’s calculated ARS value, but adapts more aggressively if the forecast records consecutive errors outside of the user’s defined tolerance for error.

The solution allows the policies to be set up by Velocity and Contribution Code (importance to the business ranking). This provides a tailored approach for each velocity product range, allowing the user to accept a higher forecast error and adaptive response factor for low velocity fractional ARS values versus higher velocity SKU locations in both over forecasting and under forecasting directions. This capability allows the SKUs to be treated individually based on their unique results.

In the example in Figure 3, the first “trip” (i.e., an exception outside the user-defined error tolerance) for the SKU-location that had this business

Response Factors																
Automatic Response for Strong Sales Trip																
Consec	ARS 0.000 - 0.100			ARS 0.101 - 0.400			ARS 0.401 - 0.800			ARS 0.801 - 3.000			ARS >= 3.001 -			
Trips	RF	SSL	E	RF	SSL	E	RF	SSL	E	RF	SSL	E	RF	SSL	E	
1	20	%	10	%	20	%	10	%	20	%	10	%	20	%	10	%
2	25	%	10	%	25	%	10	%	25	%	10	%	25	%	10	%
3	30	%	15	%	30	%	15	%	30	%	15	%	30	%	15	%
4	35	%	20	%	35	%	20	%	35	%	20	%	35	%	20	%
5	40	%	20	%	40	%	20	%	40	%	20	%	40	%	20	%
Automatic Response for Dying Sales Trip																
Consec	ARS 0.000 - 0.100			ARS 0.101 - 0.400			ARS 0.401 - 0.800			ARS 0.801 - 3.000			ARS >= 3.001 -			
Trips	RF	SSL	E	RF	SSL	E	RF	SSL	E	RF	SSL	E	RF	SSL	E	
1	10	%	1	%	10	%	1	%	10	%	1	%	10	%	1	%
2	10	%	1	%	10	%	1	%	10	%	1	%	10	%	1	%
3	15	%	1	%	15	%	1	%	15	%	1	%	15	%	1	%
4	15	%	1	%	15	%	1	%	15	%	1	%	15	%	1	%
5	25	%	1	%	25	%	1	%	25	%	1	%	25	%	1	%

RF = Response Factor (the % of this week’s Winning ARS that will be blended with last week’s ARS).  
SSL = Safety Stock Limit (expressed as a % of Review Time + Lead Time).

Figure 3. Response Factors

parameter for ARS range 1.00 to 5.00 would blend 20 percent of the current week's ARS and 80 percent of the prior week's ARS. The second trip would drive 40 percent of the current week's ARS and 60 percent of the prior week's ARS. This process continues during each cycle until the exceptions are resolved and the forecast result tuned within the user-defined tolerance for error.

## Promotions/Events

The Teradata DCM solution can build seasonal models and ARS values free of promotional demand to ensure integrity in these models for regular baseline predictions. Promotional demand and meaningful attributes like price point, display, discount and media type in the building of automatic lift coefficients using regression techniques, based on multiple years of historical promotion event details. The integrated forecasting system understands the regular forecast expectation and then automatically selects and applies the most appropriate event uplift based on this analysis, at the SKU-location level to deliver the expected forecast for the Event. The solution provides multiple event models based on the attributes and also aggregates levels within the Merchandise and Location Hierarchy to ensure all SKUs are provided a lift, even if the SKU planned for an event does not have any promotional history. The solution will then measure the accuracy of the future Event forecasts for each SKU-location combination and adjust as required to improve the accuracy based on the multiple data observations.

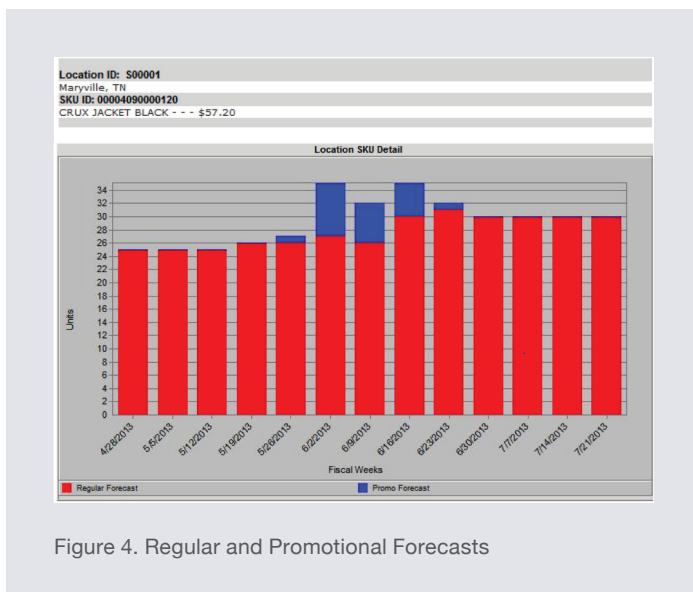


Figure 4. Regular and Promotional Forecasts

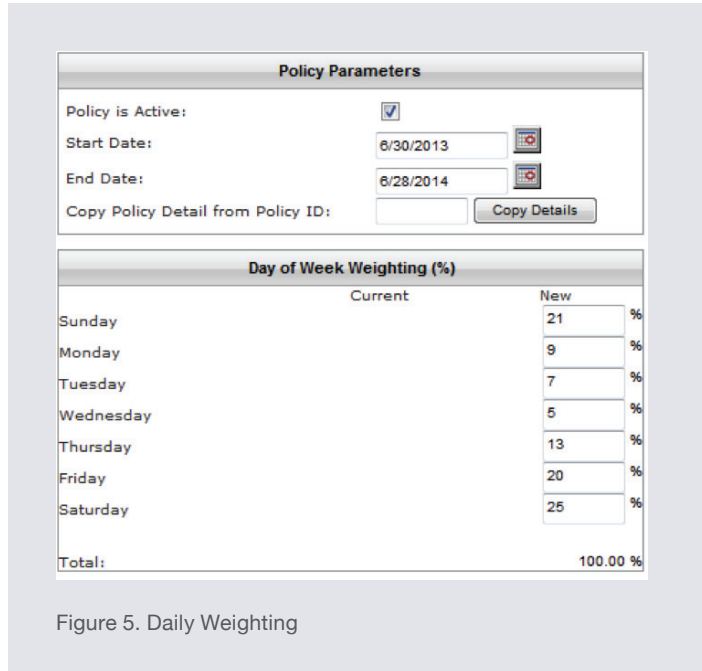


Figure 5. Daily Weighting

## Daily Forecasting and Reforecasting

The Teradata DCM solution provides the ability to build daily forecasts and re-forecast intra week based on user-defined tolerances. This is accomplished through the decomposition of the weekly forecast output to the daily level. DCM executes this routine by calculating the detailed daily demand percentage based on the daily historical sales breakdown at the location category level. The calculation takes multiple years of sales data into consideration in the calculation or the daily demand decomposition and can be conducted any time to pick up changes that may occur by location during the year or season. Once the daily breakdowns are employed to decompose the forecast to day, the daily re-forecasting routines can be used. The routines are based on user-defined error tolerances by SKU velocity. This allows the business to set up the level of focus and determine which SKUs benefit most from daily error scoring and intra-week forecast adjustments. (i.e., Fractional ARS ranges may not provide value in reforecasting, but promoted items with units of 10 or more certainly may benefit from the daily re-forecasting process, within logistical lead times allowing the business to get inventory to stores as goods are consumed.)

## APPROACHES TO DIFFERENT TYPES OF PRODUCTS

The Teradata DCM solution delivers forecasts for all SKUs across multiple retail verticals and companies:

### Basic Goods

The solution automatically assigns the best profile for each SKU-location based on the process listed previously for seasonality. Each week, the system will automatically score and apply best fit and adaptive response logic to identify outliers and adjust the forecast to the latest trend for each SKU-location combination, and then apply the appropriate Event (promotion) lift to deliver the right sales/demand forecast and the inventory forecast over multiple horizons to improve service levels and inventory productivity. Our methodology allows the solution to identify exceptions to user-defined tolerances, adjust for best results, and report the exception conditions to the users via a Web-based dashboard for review and potential adjustment of the defined parameters. Basic goods are usually replenishment products and carried for the majority of a defined season or the entire year. Basic examples: appliances, electronics, housewares, basic apparel, shirts, blouses, slacks, jackets, undergarments, cosmetics. In most cases these are the products that are generating the bulk of sales in the business.

### Highly Seasonal

Seasonal products that do not sell during the entire year will be identified as highly seasonal products and are best assigned to a shorter season profile. Additionally, Teradata DCM provides the business the ability to assign start and end forecast dates during the year, allowing the forecaster to maximize results during the peaks and stopping or significantly reducing forecasts for products during the off-season periods. Multiple years of history will be used to calculate the seasonal patterns, and promotional or end-of-life clearance demand will not be used in the calculations of seasonality or average rates of sale to ensure the next season's buy and margin is not being impacted by the unprofitable sales and season end business. Highly seasonal examples: lawn and garden product, air conditioners, sun protection, bathing suits, short-sleeved blouses and shirts, winter coats, snow boots, Christmas decorations.

### Very Slow-Moving Goods

Teradata DCM provides very slow-moving merchandise detection and forecast adjustment logic to identify the specific SKU-location combinations demonstrating slow or intermittent demand patterns. The solution scores all SKU-locations against the slow-moving detection logic, automatically identifying slow-movers, and running them through a specific Adaptive Response process for slow-moving goods. The solution then executes Forecast Bias Control to reduce the impact of negative BIAS on fractional ARS products or those products that are sold infrequently, but in quantities greater than a single unit. The ability to identify these goods and adjust automatically is the key to success in retail forecasting at SKU-location level where products with a fractional ARS value may represent the vast majority of the assortment.

**Note:** Some solution providers may say that these products should not be forecasted, or forecasted only at a higher level and then allocated a store SKU forecast based on a percentage split of the higher-level forecast. Our belief is that the ability to forecast at SKU-location is important to reducing lost sales and unproductive inventory. It is also difficult to exclude a slow moving product from a forecast process as low volume is not necessarily a constant state. For example:

- ~ Many products are not universally slow-sellers. They may sell poorly in some locations and quickly in others, or they might be slow-selling "out of season" but are higher volume "within season," even if that season is only a few weeks.
- ~ If a product takes off, there is not a mechanism within a shelf minimum logic to identify and adjust to this trend. Therefore, the business may sacrifice sales or be forced to carry much more average inventory than necessary to optimize for demand.
- ~ Aggregation of slow-selling item forecast information is valuable in determining the right demand need at the DC and for vendors. The synchronization of store-DC demand increases sales and reduces DC safety stocks. In addition, collaborating with vendors by sharing bottoms-up forecasts provides for improved vendor-to-retailer service levels. In this case, the forecast bias is as important as forecast error for DC forecasting and vendor orders. The key is to have consistency with both values, and to understand how best to tailor your merchandising and replenishment strategies to drive results.

- ~ Forecasting provides a repeatable unbiased process that can handle millions of decisions with little or no manual intervention.
- ~ Forecasting at a higher level may seem to reduce overall forecast error and bias. However, Teradata has proven in customer engagements that the allocation of a higher level forecast to the lower level introduces more forecast error at the lowest store-SKU level than starting with a store-SKU forecast. Additionally, individual forecast trends (e.g., seasonal variability, trending up or down to history, promotional variability) cannot be determined if the trends are averaged to a higher level.

## New Item Forecasts

Teradata DCM provides an automated parameter-driven solution called Intelligent Product Introduction to quick-start forecasts for new items by attaching the new product to SKU or SKUs sold historically in the business. The solution employs merchandise hierarchies, locations, and secondary attributes (i.e., screen size, color, fabric, and processing power) to identify reliable matches rather than relying on experience or intuition to make the linkages. The recommendations are presented to the users and can be automated or reviewed before approval in building the SKU forecasts at the SKU-store level. The users have the option of setting the relationships and can set start and end dates, employ a lift calculation and use actual sales data by store of forecasts to shape demand. The ability to quick-start new items with an accurate forecast allows the business to ensure the initial launch is supported to optimize selling opportunities and inventory productivity reducing these occurrences or customer disappointment or the Bull Whip effect on the Supply Chain.

## Promotional

The Teradata DCM solution separates regular from promotional demand and automatically generates the promotion forecast based on the event attributes for each SKU-location combination. All product groups are impacted by promotion events and require the event lift calculation to be applied to the baseline forecast to ensure the right quantity of product is at the right place and time to support the marketing event in any retailer. The DCM solution provides an on-line Web-based user interface to allow the event attributed details to be

entered and calculated or the solution can accept an automated feed of information from other promotion planning solutions to generate a detailed forecast. The forecasts are generated through best-fit logic, and the corresponding results are scored and tracked for each event allowing the solution to improve as more observations are recorded. DCM routinely supports multiple retail formats and events such as ROP, Web-Based Events, Flyers, Radio, Television, or In Store Marketing Events.

## Clearance

Teradata DCM separates clearance demand from regular demand to ensure the impact of clearance does not impact normal demand patterns. Additionally, the solution uses adaptive response to adjust to the dying forecast trends seen during a products end-of-life period, reducing the occurrences of overstocking and allowing for a more appropriate sell-through of inventory. The user has the ability to view the forecast into the future as far as 65 weeks to review and confirm that the expected changes in a product's life cycle are set to occur. Further, the adaptive response policies can be differentiated based on product contribution codes (e.g., popularity based on unit, dollar and gross margin) and volume allowing the business to be more aggressive as the season style, SKUs or product types approach their end-of-life stage. The Teradata DCM product also allows the user to establish an end-of -life date for the products allowing the forecaster to adjust to the expected end-of-life date and combine this with the replenishment solutions to ensure inventory is not ordered to exceed this period.

## One-Time-Buys

The user need only determine the time periods where the one-time-buys will be sold. The Teradata DCM solution allows for linking of historical SKUs to build forecasts for new SKUs, provides for default SFs (Seasonal Factors) and ARS values, or allows the user to assign these values. The total demand period will be forecast for the one-time-buy items at the lowest level and either rolled up to the distribution center (DC) or corporate level allowing for purchases to be planned to stock the products. The Teradata DCM solution also provides allocation functionality that allows the user to push out one-time-buys using forecast-based algorithms or historical sales percentage splits to maximize sell through and inventory cover.

## Imports

The Teradata DCM solution allows for forecast visibility for 65 weeks, optimizing the prediction of demand at store and DC for long lead time import product lines. These products typically require lead times that can be many months in advance of the need for the actual product. Teradata DCM provides multiple algorithms including long-term trending, delivering accurate predictions of sales and order forecasts to impact the Buy of the import products. Since the values are calculated beginning at SKU-store, the results can be employed to influence the future store order or allocation quantity.

## Lost Sales—Revised Demand Calculation

As DCM evaluates and scores forecasts during each cycle, the solution also captures the occurrences of lost demand or sales. When a stock out condition is identified, the forecast is used to revise demand during the period of stock outs (regular or promotion periods) to

ensure the forecast credibility is not impacted. Revised demand calculations are employed in all forecasting routines to ensure seasonal models, de-seasonalized average rates of sale and promotion events are not impacted by the stock out conditions. The values are also reported weekly to the user so the business can better understand what was left on the table and lost to the business. Exception alerts are also provided to the user for these conditions and service levels scored appropriately.

## IS A FORECAST HELPFUL?

Demand Forecasting is an industry best practice, and Teradata believes that forecasting delivers financial benefit for all products within the supply chain. In fact, most companies are using forecasting today for at least part of their assortment. This is executed to improve results across the omni-channel for goods on auto replenishment (e.g., basic SKUs or seasonal basics) as well as one-time-buy merchandise or push products (e.g., fashion goods that had previously been allocated to stores using model stocks or min-max values). A solid forecasting methodology—combined with the optimal replenishment or allocation decisions quickly rewards retailers with improved sales, markdown reductions, and increased turns. Additionally forecasting also drives benefit across the organization when applied to areas outside of the supply chain. Companies are now expanding forecast sharing across the business to include business intelligence reporting, labor scheduling, assortment and capacity planning, marketing, campaign management, vendor collaboration and store communications. The ability to collaborate internally and externally provides another layer of improvement and return on investment from demand planning tools like Teradata DCM.

In conclusion, Teradata asserts there is great value in forecasting all products, and that retail and retail like companies (VMI, CPG companies that perform Direct to Store Deliveries) that make the effort to execute this discipline will be rewarded with better replenishment, allocation, and promotion execution capabilities, reducing the occurrences or stock outs and overstocks at SKU location level driving significant increases in profits.

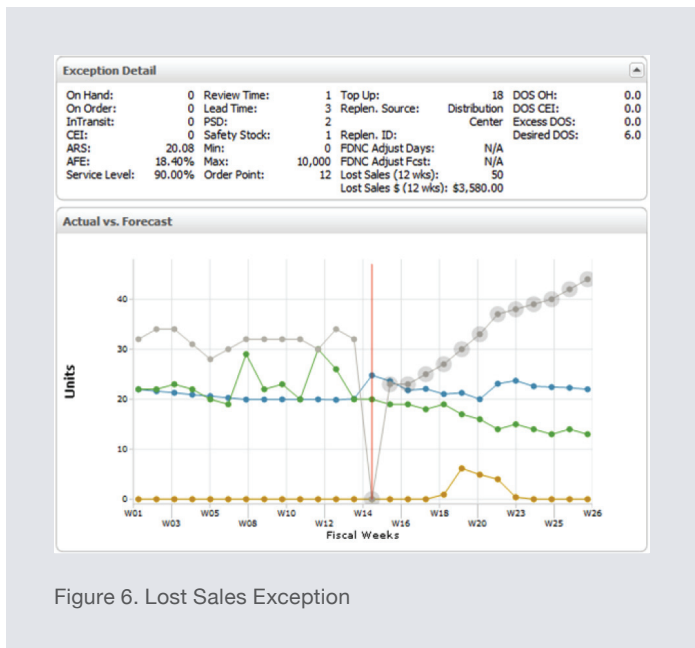


Figure 6. Lost Sales Exception

