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Switching Cost Methodology
Docket No. UT-023003

Switching Cost Methodology Manual

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1.0 Introduction

This document describes the analytical methodology used within the VzCost system to estimate investments for central office switching. These investments are used within the VzCost system to develop the unit costs of any service that uses capacity provided by the switching system network infrastructures. This document describes the process, from the collection of basic investment and design information through the creation of Basic Cost (BC) elements within VzCost. The general process of combining BCs to generate unit service costs is described in the general Cost Manual.

2.0 Scope

The VzCost Switching investment development process addresses the central office switching functions employed to provide usage calling and vertical features. This infrastructure supports all services that require central office switching capacity (end office host and remote switches, tandem switches, and Operator/Directory TOPS switches). The most important of these services are end office line and trunk ports, usage calling, and central office vertical features. The Switching investment development process develops costs for the multiple applications provided by these major switching systems equipment components.

The forward-looking design for all Verizon switching services employs digital switching (end office, tandem, and TOPS) systems. The percent mix of analog and digital line ports reflects the anticipated purchases of these equipment components in the upcoming planning year.

3.0 Modeling Approach

The VzCost switching investment development processes use capacity cost modeling. In general, capacity cost models rely on more macroscopic service and network characteristics such as average fill factors for a given type of switching equipment.

Capacity cost models identify the typical network configurations and associated investments used to support services. Appropriate units of capacity for each component of the configuration (e.g. port utilization, busy hour CCS, processor utilization, etc.) are used to create investment estimates for units of capacity. These capacity investments are allocated to specific services by using the appropriate capacity consumption parameters for the service such as processor milliseconds, number of line ports, minutes of use, and number of trunk ports.

Complex but manageable, capacity cost models can be created for switching networks and services. The underlying technology used in these networks is highly complex but a limited set of standard designs can be identified for the configurations used to deploy this technology on a forward-looking basis. Each of the many switching services has a unique set of central office engineering design criteria. Capacity cost models for each of these service configurations can be defined. A capacity cost model can be readily expanded and enhanced to accommodate new services by using the inherent capacity cost outputs to study new services and/or equipment configurations.

In addition to the network and service design configuration, the switching capacity cost models require state specific inputs for many parameters that drive investment estimates within the configuration models. These parameters include the types of switches deployed in each state (e.g., 5ESS, DMS-100, GTD5, EWSD), number of switches by line size, equipment utilization rates and the mix of network architectures (e.g., percent mix of analog, TR08 IDLC, and GR303 lines). The projected deployment provides a reliable basis for estimating the parameters used in the capacity cost models.

4.0 General Methodology

This section describes the general methodology used for the switching investment calculations. Subsequent sections will describe specific design and technology assumptions.

Figure 1 presents the overall process flow for the Switching Investment Development. The process is divided into three main stages: Switching Investment Models, Investment Element Calculation and Basic Component Calculation.

4.1 Stage 1 – Switching Investment Models

4.1.1 Development of Total and Unit Switching Investments

The first step in the development of the switching investments is the creation of central office engineering models for a number of various cost drivers that impact switching investment.

The material investments for the 5ESS and DMS-100 switches were developed using the Switching System Cost Information System ("SCIS") model developed by Bellcore (now known as Telcordia) and Verizon's COSTMOD program for the GTD5 switching system. SCIS is a computer system that is comprised of two modules: SCIS/Model Office ("SCIS/MO") and SCIS/Intelligent Network ("SCIS/IN"). SCIS/MO develops switching investments and the processor-related investments associated with features that do not require any specific, unique hardware. SCIS/MO allows the user to construct a customized "model office" based on that user's variables that produce both total and unit switch investments. SCIS/IN, using the unit investments generated by SCIS/MO, develops incremental investments associated with vertical switch features.

The Cost Modeling System ("COSTMOD") is a PC-based software program developed by Verizon that estimates material investments for GTD-5 EAX host switches and remote switching units. The investment estimates are based on inputs such as the number of access lines and trunks served as well as inputs on traffic characteristics such as busy hour originating and terminating ("O+T") CCS per line and busy hour O+T CCS per trunk. The investment calculated by COSTMOD is based upon investment tables that reflect the vendor price list.

COSTMOD is composed of two cost modules: GTD-5 EAX Switching Cost Module and the Vertical Services Application or Features Cost Module. The GTD5 EAX Switching Cost Module enables the user to develop switch unit investments for major categories based upon individual switch inputs and defaults. The unit investment of the major GTD-5 switch hardware and software components is determined based upon the switch architecture and the network functional elements of the switch.

4.1.2 Representative Model Office Development

SCIS/MO was used to construct a model office that is representative of a typical office in the network. Key cost drivers were determined, such as the number of access lines, the type of line peripherals, busy hour CCS per line, and the like, based on current trends adjusted to be forward-looking. After these data are input into SCIS/MO, the program determines the investment costs for that model office.

To "build" the model offices, the state's actual engineering line, trunk, and traffic data was reviewed so as to capture the existing relevant office parameters for the current switching network. Each of the state's host and remote switches was assigned to one of the SCIS representative model offices using the following criteria:

1) Type of Switch (GTD5, 5ESS, DMS-100)

2) Host or Remote Switch

3) Number of lines per switch

4) Busy Hour CCS per Line

After each switch was assigned to one of the representative model offices, the total and unit investment results from SCIS/MO were used as the basis for the forward looking investment for that switch. For example, a 5ESS switch whose line size falls between 7,501 and 15,000 will have different investment inputs than a larger 5ESS switch whose line size fall between 25,001 and 40,000 lines. The individual total and unit SCIS/MO investment results were weighted by the number of host and remote switches that fall in each category of representative model offices. A similar process was conducted for the 5ESS switches, DMS-200 tandem switches, and the DMS-200 TOPS (Telephone Operator Position System) switches. For the tandem/TOPS model, the state's current tandems and TOPS switches were assigned to one of the representative model offices based on the number of trunks in a given switch.

4.1.3 Cost Drivers

There are several key cost drivers that impact the total investment (as modeled in SCIS and COSTMOD) in an individual central office switch as well as the accompanying unit investments. They are as follows:

- Getting Started Costs (*i.e.*, switch processor, common equipment, spares, breakage)
- Line Termination (physical line ports)
- Line CCS
- Trunk CCS

Key central office engineering inputs were identified that will impact the switch investments. They are as follows:

- Total Lines per Central Office
- Line Port Technology Mix (Universal/Analog, GR303 IDLC)
- Average Busy Hour CCS per Line
- Average Busy Hour Call Attempts per Line
- Total Trunks per Central Office
- Trunk Port Technology Mix (DS1, STS-1)
- Average Busy Hour CCS per Trunk

By varying the inputs listed above, a series of model office runs were created that captured the impact of changes to the inputs on the total investment outputs. For example, the SCIS Model Office was run for six line sizes for host switches. In addition, Verizon NW varied the busy hour CCS per line, the busy hour calls per line, and the number of trunks per office. The physical line port termination costs vary by the line port technology. Separate representative model offices were therefore constructed for each of the two line port technologies (analog (used for copper and UDLC lines) and GR-303 IDLC).

The investment per Line CCS is dependent on the amount of traffic, measured in CCS, per line and the accompanying line concentration ratio ("LCR," essentially, the ratio of lines to ports) for a given central office. In general, the cost per line CCS increases as the LCR decreases. In other words, the higher the busy hour CCS/line, the more paths are required in the switching fabric (lower LCR), and the higher the cost per Line CCS. In the SCIS model, the investment per Line CCS is a capacity cost that captures that

investment associated with a given line unit/module engineered for a given busy hour CCS per line divided by the capacity (objective) CCS per line. Therefore, all central offices (for a given line port technology) with the same line concentration ratio will have the same investment per Line CCS.
End office trunk investments can be recovered in one of two ways; (a) an investment per trunk CCS is converted to a cost per minute of use, or (b) a dedicated trunk port is recovered as a monthly cost per port. In general, the key cost drivers are the actual busy hour outgoing plus incoming (O+I) CCS per trunk and the trunk port technology (DS1 versus STS1/DS3).

4.2 Stage 2 – Switching Container Program

4.2.1 Switching Container

The Switch Container is a VzCost program of converting SCIS model office total and unit investment outputs into Investment Elements (IE). The output is suitable for uploading into VZCost. Using the mapping process in the Container Program, the program allows the user a means of documenting the investments used to create IE(s).

The Switch Container also employs a Switch Demand table and the Switch Constant table to house the values required to perform the weighted investment computations used in the Switch Container. The Switch Demand table contains values that are specific to the state under study (e.g., total 5ESS access lines). The Switch Constant table houses standard switching inputs that will apply to all state jurisdictions.

As discussed previously, each host and remote switching wire center in the state under study was assigned to one of the representative model office constructs based on its central office design characteristics (*i.e.*, lines per office, busy hour CCS per line). In essence, a profile was created that assigns and tallies the number of host and remote switches to each of the model office configurations. Next, the state specific forward-looking parameters were applied to weight the various outputs from the representative models for the following; (1) percent mix of analog (including UDLC and copper) and GR-303 IDLC lines, (2) percent mix of DS1 versus STS-1 trunk peripherals (5ESS only).

The total investments were calculated by summing the total investment per switch for each of the representative model offices based on the actual number of switches in a given state that fell into each of the categories (*e.g.,* 5ESS switch between 25,001 and 40,000 lines whose BH CCS per line is greater than 3.4 CCS). The final step was a calibration that adjusts the total lines and trunks produced by the model (either up or down) to match the state's actual line and trunk counts as provided by Engineering.

The unit investments were calculated in a similar manner. Unit investment outputs from SCIS and COSTMOD are weighted by switching system (5ESS, GTD5, DMS-100, EWSD) and equipment utilization factors (if appropriate) are applied.

4.2.2 The Definition of Investment Elements (IEs)

Within the Switching investment development processes, investment elements (IEs) constitute the investment for a unit of network capacity required to create a specific service within the switching infrastructure. A complete investment for a service may consist of a single investment element or several investment elements may be required for a complete service

The investment elements are defined to capture the fundamental unit and total investments required to complete a cost study for the service under study (e.g., analog line port, Calling Number Delivery feature).

In summary, a large set of investment elements is defined for each switching function. These investment elements are required to properly model all potential services and accurately capture the variation in economic design for a given geographic area or jurisdiction. These investment elements are combined in the third stage of the process to produce the Basic Component investments for services.

4.2.3 Output Data

The investment elements for a particular switching service study are created by executing or "running" the container database. Each container of the database selects the appropriate element investment and state specific demand data and calculates the investment for the specified Investment Element. Investments are calculated by account class and are categorized as direct and shared as explained in the Cost Manual. The calculated values are output into a table that is input into the third stage (BC) of the process.

4.3 Feature Investment Development

4.3.1 SCIS/IN and COSTMOD

In addition to the SCIS and COSTMOD model office development modules, each model contains a separate module that develops unit investments for the individual vertical services or features supplied by the switch. In the case of SCIS, this module is referred to as SCIS/IN.

SCIS/IN and COSTMOD develop unit investments for each individual vertical feature by switch type. Separate investments by switch type are developed since the individual switching system architecture impacts how the feature is delivered in that switch which impacts the investment required. In order to develop the weighted unit investment for the state, the Feature Investment Weighting Model is employed to weight the individual feature investments by switch type. The Feature Weighting Investment Model is an

EXCEL spreadsheet that calculates the weighted unit investment by vertical feature and creates the investment element (IE) output.

5.0 Stage 3 – Basic Component Calculation

5.1 The Definition of Basic Components

Within the switching processes, a Basic Component (BC) contains the average investments required to create a specific service element in a defined geographic (usually state) area. For example, the average investment required to provide an Unbundled Line Port in a specific state jurisdiction is a typical BC. BCs are calculated by combining appropriate Investment Elements (IEs) using weightings and parameters that reflect the technical characteristics of the service. For example, the Line Port reflects the line port technology mix (analog versus digital line) and the associated cross connect frame (MDF and DSX, respectively).

5.2 The Basic Component Calculation Process

BC Families

Within VzCost, BCs are calculated in arrays of formulas called BC families. The Switching BC families combine all the IE options available to create a particular BC and determine an average investment for that BC in the study area. The formulas that comprise a BC family apply the state specific parameters to weight the IE options according to their expected occurrence.

Outputs

The BCs for a particular Switching service study are created by executing or "running" the BC families. Each BC family selects the appropriate investment elements and state specific demand and/or constants and calculates the average investment for the specified BC. BCs are calculated by account class and are categorized as direct and shared as explained in the Cost Manual. The calculated values are output into a table that is input into the final costing (Coster) process. The BCs form a complete set of investments for the Switching service elements.

SWITCHING INVESTMENT STUDY WORK FLOW