EXHIBIT RAM-8
HAI xDSL Adjunct Model
Description

Introduction

The HAI xDSL Adjunct Model estimates the TELRIC of ADSL- and HDSL-capable and ADSL- and HDSL-equipped loops according to a set of user-adjustable investment inputs. The model functions as an adjunct to the HAI Model version 5.2a and uses certain cost and cost factor outputs produced by the HM to develop its xDSL cost results. The Model adds per-line monthly costs for ADSL (both "conventional" and "splitterless") and DS-1 (using HDSL four-wire and two-wire equipment) loop and network equipment to unbundled loop costs obtained directly from the HM. The results include these specific costs:

"Average xDSL-capable loop"

Average ADSL- and HDSL-capable loop cost as computed by the HM for all-copper and DLC-served loops.

A user-specified multiplier converts the HM two-wire basic loop cost to an equivalent four-wire cost for the four-wire HDSL case. (Current full-rate HDSL transmission requires four-wire transmission, and "HDSL-2" requires a single pair to transmit DS1 signals. HDSL-2 equipment is becoming commercially available).

"Additional voice network UNEs"

Voice network unbundled network element (UNE) cost, which is the difference between the HM-computed UNE "platform" cost and the average loop cost and thus represents the total of the voice network UNEs.

"splitter at NID"

Cost of the splitter required at the customer's premises for "conventional" ADSL service; in a forward-looking design, the splitter will be mounted in the customer's NID (Network Interface Device).

"remote terminal upgrade"

Cost of DLC remote terminal and associated wire center equipment upgrade required to support ADSL service on existing DLC equipment "splitter at wire center"

Cost of splitter in wire center used to separate the ADSL data stream from the baseband analog voice signal at the wire center (for copper loops)

"DSLAM or HDSL terminal unit"

For ADSL service, cost of the digital subscriber line access multiplexer (DSLAM) in the wire center (copper loops) or the DSLAM components on the ADSL channel unit (DLC loops).

For HDSL, the cost of the HDSL terminal units (HTUs) at the customer and wire center ends of the connection. Note that both of these equipment items are "network" components; unlike ADSL, the customer-end terminal unit is assumed to be owned, installed, and maintained by the service provider.[1]

"dedicated transport for ADSL"

Dedicated transport cost derived from the DS-3 value computed by the HM. For ADSL, the model assumes that a DS-3 will be shared by many users through a packet-switching technique such as ATM.

"dedicated transport for HDSL"

Dedicated transport cost derived from the DS-1 value computed by the HM. An HDSL subscriber requires a dedicated DS-1 interoffice connection.

"ATM edge switch port"

For ADSL-equipped loops, fast packet switching (typically ATM) and associated FPS port cost per line. A CLEC may choose to obtain an end-to-end connection from the CLEC's customer's premises to the CLEC's ATM POP using an ILEC-provided fast packet switching service. These items represent the TELRIC of these functions.

"element manager"

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[1] Under these assumptions, HDSL is not a "service;" it is an underlying technology often used by ILECs to deliver T1 service to subscribers. HDSL-supported T1 service is no different from T1 service provided by more conventional transmission techniques, and subscribers usually are not aware that the HDSL equipment is used.

Element manager (ADSL operational support system) monthly cost per line for ADSL service.

"ATM core switching" (Optionally) (see ATM edge switch port)

"total xDSL lines"

Total line count in each category for which the model computes costs.

"total xDSL cost/line/month"

Total xDSL monthly cost per line consisting of all the preceding elements, including any optional ones as selected by the user.

The following loop definitions apply to the elements addressed by the xDSL Adjunct Model:

A *basic loop* is a transmission facility capable of transmitting communications, in the voice band, between the incumbent's central office switching element or elements and the network interface device at the customer premises.

An *xDSL-capable loop* is a basic loop from which any components that impair data transmission (such as loading coils) have been removed so that the loop's electrical characteristics will permit transmission within the voice band as well as within one or more channels in frequency ranges above the voice band. Such channels are derived through end user as well as network-deployed transmission enhancing equipment subsequently added to the loop, such as DSLAMs and splitters. An xDSL capable loop must be certified as capable of supporting the specified advanced data service without undue spectral interference to other analog or digital signals carried on wire pairs in the same sheath. [Note that all loops are xDSL-capable in a forward-looking model].

An *xDSL-equipped loop* is a basic loop that includes all necessary transmission enhancing equipment within the local network such as a DSLAM and splitters to deliver communication within both the voice band and one or more derived data channels that are transmitted above the voice band when the retail customer provides compatible transmission enhancing equipment at the subscriber's premises. The xDSL equipped loop must deliver voice and data traffic without undue spectral interference to the first technically feasible point of interconnection in the central office or, if there is no technically feasible point of interconnection in the central office, then at some technically feasible point further into the incumbent LEC's network.

As noted above, the model uses the HM basic loop and transport costs, line counts per wire center, and certain other parameters such as default economic life and capital structure figures as the foundation for calculation of xDSL-capable and xDSL-equipped loop costs. The model computes its own annual cost factor for xDSL equipment (remote terminal upgrades, DSLAMs, splitters, and HDSL terminal units) according to user-adjustable inputs. The input sheet repeats the default values for economic life, salvage value, and capital structure for the user's convenience. The remaining user inputs principally include equipment investment for a number of ADSL- and HDSL-related items, equipment discount factors, and subscriber penetration. There are also penetration thresholds governing the minimum number of xDSL lines per wire center that are necessary before the Model computes costs for the wire center.

The model uses cluster-level HM network investment output summaries as the basis for its xDSL investment and cost calculations. VBA (Visual Basic for Applications) modules contained in the workbook generate a list of wire centers and compute access line totals for each wire center. All xDSL calculations are made at the wire center level, and the summary sheet reports line-weighted average results across all wire centers in the study area. The model computes capital carrying costs directly using user-supplied inputs for economic life and salvage value, along with cost of capital parameters, and it calculates related network expenses (including maintenance) and shared costs according to corresponding ARMIS-based numbers available in the HM density-zone expense module. There are separate sections in the 'calculations' worksheet of the model treating ADSL, G.Lite (splitterless ADSL), HDSL, and HDSL-2; all-copper and DLC loops are treated separately within these sections.

Calculations

Figures 1, 2 and 3, attached, illustrate the connections and equipment addressed by the model's calculations. Figure 1 shows the all-copper ADSL case while Figures 2 and 3 show the DLC case and the ATM network respectively.[2]

All investment and cost calculations may be found in the 'calculations' and 'summary' worksheets. The model "imports" basic loop and transport costs from the HM, as noted earlier. It estimates four-wire loop costs for the HDSL case by applying a user-adjustable multiplier to the (two-wire) basic UNE loop produced by the HM.

The model computes total investment in ADSL and HDSL equipment in each wire center by first calculating the number of access lines to be equipped with xDSL devices and then determining the total investment in xDSL equipment. Before computing the equipment investment, the model compares the line count (determined by multiplying the eligible lines by

[2] The corresponding HDSL connections are not shown in either figure. The HDSL case is somewhat simpler than the ADSL case as no packet switching is required. HDSL is just a loop transport technology and may be applied to all-copper loops or to loops served by DLC by the addition of a suitable channel unit that performs the HTU function. Such equipment has been available from several equipment manufacturers for some time.

the penetration factor for the xDSL technology in question) to the corresponding line threshold.[3] If the line count falls below the threshold, the model forces the calculated xDSL line count to zero for the wire center and computes no investment in xDSL equipment for the wire center. The inputs contain separate threshold values for ADSL (set at thirty-five lines as the default) and HDSL (where the default is one DS1 connection).

There are separate calculations for ADSL, G.Lite, HDSL, and HDSL-2. ADSL investment includes remote terminal equipment upgrades (for DLC-served lines), digital subscriber line access multiplexers, or DSLAMs, and splitters (as required), both for all-copper and DLC-served loops. The investment does not include the customer's ADSL modem, because the subscriber normally provides such equipment. HDSL investment includes HDSL terminal units, or HTUs, at both ends of the loop. Because HDSL is a transmission technology used by an ILEC or a CLEC to provide DS1 service and not a "service" in its own right, the carrier will install and maintain the terminal devices at both ends of the loop connection.[4]

The model includes, in addition to that for the xDSL equipment, NID-mounted splitter investment for conventional ADSL as well as wire center splitter investment for copper loops, along with multipliers for installation. There is also a separate calculation for investment and costs for DSX-3 panels as shown in Figure 2 as well as for ATM switching and an ADSL Element Manager shown in Figure 3.[5]

In conventional DLC systems carrying only narrowband user information such as voice and voiceband data signals, the system assigns each active conversation to a pair of timeslots, one upstream and one downstream, that carry the digitally-encoded signal at the 64 kbps (DS0) rate between the remote terminal and the integrated DLC interface in the end office switch (or, in the case of universal DLC, the central office terminal). Because ADSL effectively expands the bandwidth to a given subscriber to carry high-speed digital signals, additional feeder bandwidth must be available in DLC systems to accommodate the high-speed signals. The model includes investment in DLC terminal components required for the increased

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[3] There are separate threshold values for ADSL, G.Lite, and HDSL. The default values are thirty-five lines for the ADSL cases and one (DS1) for HDSL. These values may be altered by the user in the ADSL and HDSL inputs worksheets.

[4] Aside from the fact that the HDSL connection is transparent to the user, the HTUs at the customer's premises and at the wire center (or, in the case of DLC systems, the HTU channel unit in the RT) must be compatible. This usually means that they will be made by the same manufacturer.

[5] Note that, in a forward-looking model such as the HM and the HAI xDSL Adjunct Model, all loops are xDSL-capable. In an existing network, an automated loop qualification system is necessary to avoid costly and time-consuming verification that a specific loop is in fact capable of carrying xDSL signals. The prequalification system should be accounted for in the ILEC's ARMIS computer accounts.

bandwidth[6]

Once the model determines investment for each xDSL category in each wire center, it calculates capital, maintenance, and operating costs. Capital carrying cost calculations use the economic and financial factors input by the user. The default values are those found in the HM. The model, for convenience, repeats in the 'economic inputs' worksheet the economic and financial factors used in the HM run used to produce the underlying data for the xDSL model. These factors appear in cells adjacent to the user-adjustable input cells for comparison. The model calculates "direct" annual costs as the sum of the capital carrying costs and maintenance costs. Capital costs are derived using an annual cost factor developed from the 'CCCFactor' worksheet, and the model computes maintenance costs according to ARMIS-derived expense-to-investment ratios as used in the HM.

As is the case in the HM, the xDSL model assigns costs for general support facilities (GSF) according to relative investment in each of the xDSL categories. The GSF values obtained from the HM run are thus added to the annual direct cost to produce total annual cost. The model then determines the monthly unit cost for each investment category; the unit cost calculation includes gross-up factors for wholesale uncollectibles (computed from ARMIS reports), corporate overhead (which is user-adjustable), and miscellaneous taxes (also adjustable by the user). The cost calculations include an annual carrier-to-carrier operations expense, which covers "customer service"-like functions for the wholesale case. The default value for this number is small, $1.92 per line per year, and the total is spread over all cost elements according to investment. It should be noted that part of this expense is double-counted, because the loop and transport UNEs imported from the HM model run also contain a portion of it. This calculation is thus somewhat conservative.

The 'summary' worksheet displays the company being studied and cost results, including xDSL-capable loop, transport, xDSL equipment, element manager, and, if selected by the user, packet switching costs for ADSL service. The summary sheet calculates the weighted average of the equipment costs determined in the 'calculations' worksheet at the wire center level. It displays results for all-copper and DLC-based ADSL- and HDSL-capable loops, along with the total addressed market for ADSL, ADSL lite, HDSL, and HDSL-2 equipped loops.

The model computes costs for ATM edge switching required to separate bit streams for various service providers from commingled DSLAM output streams. The calculations assume a centralized edge switching function. The packet switching calculations are based on

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[6] A corresponding increase for all-copper loops is not necessary, because the required bandwidth is available in both the distribution and feeder segments of the loop. The bandwidth increase is only an issue with DLC systems using fiber feeder connections; although it is technically possible for DLC systems using copper feeder to carry ADSL signals, it is not economically feasible.

total average ADSL usage, which in turn is based on a user-specified usage input expressed as the number of ADSL subscribers that can be carried on a DS-3 facility. This factor reflects the fact that, in a packet-switched environment, a subscriber's terminal device does not typically transmit or receive data 100% of the time. The model assumes the CLEC will provide its own transport from its POP to the ILEC ATM edge switch.

The model bases its dedicated transport calculations for ADSL and HDSL on HM results. The ADSL transport costs are derived from the HM DS-3 monthly cost, the sum of the maximum downstream and bidirectional data rates, and the ADSL activity factors for multiline business lines and single line business and residential lines. The calculation recognizes the fact that interoffice transport bandwidth will be shared among several users via ATM or some other suitable packet-switching technique. The HDSL transport cost is the same as that produced by the HM for DS-1 dedicated transport.

The model's results are conservative in several regards. First, the equipment discount factors are lower than the factors that would realistically apply to large ILECs, who buy equipment in very large quantities (and often in "megabids"). The model also double-counts the carrier-to-carrier customer service expenses. Also, although there is an explicit input for the ADSL Element Manager, this function will commonly be performed by existing computer equipment already accounted for in the HM's general purpose computer investment calculations. Finally, the model always computes investment in DSX3 panels, even though they would not be used in many circumstances (e.g., when backbone connections are made at the OC-3 rate).

It is particularly important to recognize that, because the model does not consider revenue in its final cost calculations, it ignores the fact that the loops carrying ADSL signals also are used for basic switched telephone service and the basic loop costs are offset by local switched service revenue.

Operation

To operate the model, one must first run the HM for the desired study area using the density zone expense module. Once the HM completes, the user must copy the expense module (left open at the end of the model run) and the workfile (written into the "workfiles" subdirectory under the HM52 directory) into the directory containing the HAI xDSL Adjunct Model. The expense module must be renamed "exp.xls" and the workfile renamed "workfile.xls."

Once the expense module and workfile have been copied and renamed, the user opens the xDSL model. When the dialog box appears asking whether the module should be opened in read-only mode, the user should press "yes." A second form then appears with a copyright notice; pressing "OK" removes the form. The next form that appears contains an abbreviated explanation of how the model is to be executed. The user should then press "run," and the model will then obtain the information it needs from the expense module and workfile. It next copies formulas in the 'calculations' worksheet to accommodate the number of wire centers in the study area.[7]

The "xDSL inputs" worksheet contains all user-adjustable inputs, including investment in various ADSL and HDSL components, both at the customer's premises and at the wire center or RT location, penetration rates, discount factors, cost of capital, economic life, and capital structure. The user can recalculate the workbook after adjusting any of these numbers by pressing <F9>. This worksheet also contains an option box which, when checked, includes all business lines in the ADSL calculations. When the box is not checked, the model includes only single-line business lines. There is also a "combo box" that allows the user to select from a range of basic loop cost inputs: the separate copper and DLC-served HM loop costs, the weighted average HM loop cost, or manually-entered combined or separate copper and DLC costs.[8] The "xDSL inputs" worksheet is locked (without a password) to prevent inadvertent changing of calculations or formats. Most of the inputs are denoted by a blue typeface; all cells not containing user inputs are locked. A few inputs, marked in red, are "linked" to HM outputs so that the HAI-generated values are automatically used by the xDSL model. These cells are, however, unlocked, so the user can enter any desired value in place of the HAI output link.[9]

The 'summary' worksheet shows the model results. It also includes a user option box to allow the user to specify the inclusion of packet switching/routing in the ADSL calculation. This box is normally unchecked, so that packet switching costs are not included in the ADSL results. Because many CLECs will provide their own ATM switching, the computed packet switching cost will often be superfluous. This worksheet is also locked, again without a password, to keep the user from writing over calculations or altering formats.

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[7] The model contains a single row of calculations for "compactness." A VBA module in the model counts the number of wire centers in the company being studied and copies the calculations to accommodate all wire centers.

[8] This flexibility is necessary to accommodate local commission decisions to set basic loop UNEs at levels different from those computed by the Model.

[9] The G.lite inputs are linked to the corresponding conventional ADSL inputs and locked. This allows the model developer the flexibility to add new inputs for G.lite without changing the Model structure if such input changes become necessary as equipment prices evolve.

The ‘density zones’ worksheet disaggregates the cost results shown in the ‘summary’ worksheet into density zones which may be defined by the user. All of the user options affecting the ‘summary’ results flow through to the disaggregated results. The user may specify three density zones by entering the lower boundary of each density zone into cells A6, A7, and A8 of the ‘density zones’ worksheet. The selected zone boundaries should coincide with those defined in HM5.2a. The fourth zone shown in the sheet is fixed and pertains to Manhattan wire centers. The ‘wire center classification’ worksheet sorts all wire centers in the study area into the density zones defined by the user according to the line-weighted average line density of each wire center.

Conclusions

The HAI xDSL Adjunct Model is a compact, easy-to-use tool for estimating the TELRIC of various xDSL (and support) services provided by ILECs. It uses results produced by the HAI Model as input data, and there is a number of user-adjustable inputs governing investments in equipment and installation, capital structure and economic factors. It retains the TELRIC principles embodied in the HM in its internal calculations, and its results are suitably conservative, also in keeping with the philosophy of HM.

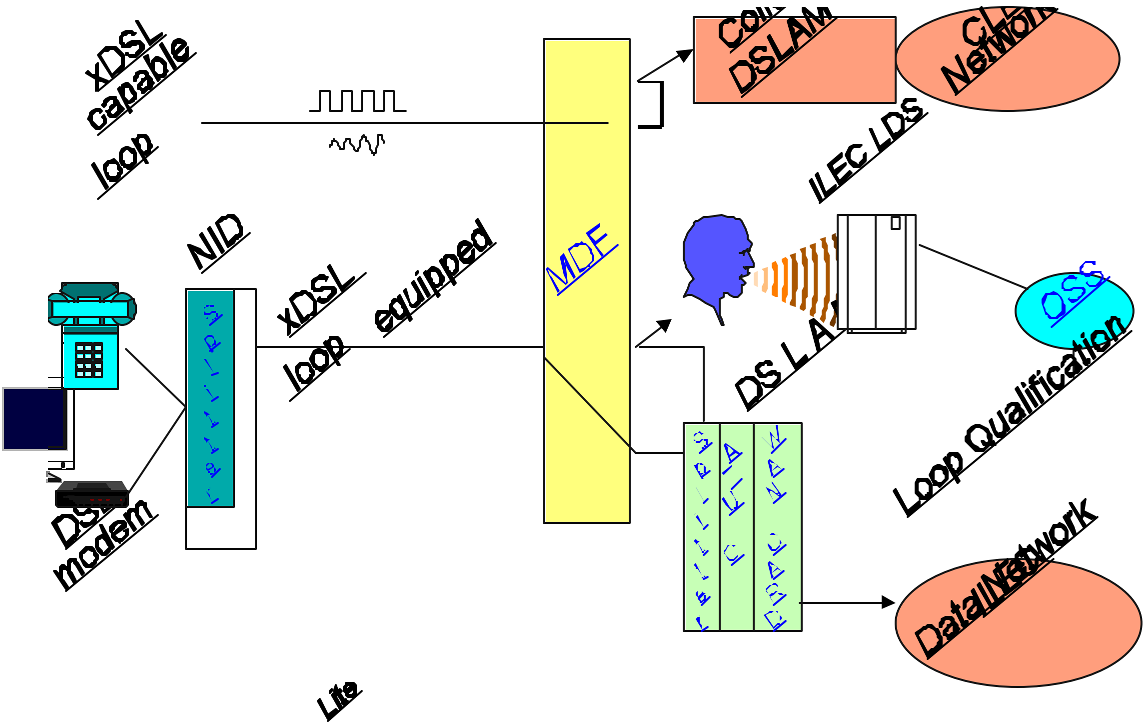

Figure 1
DSL over home run copper

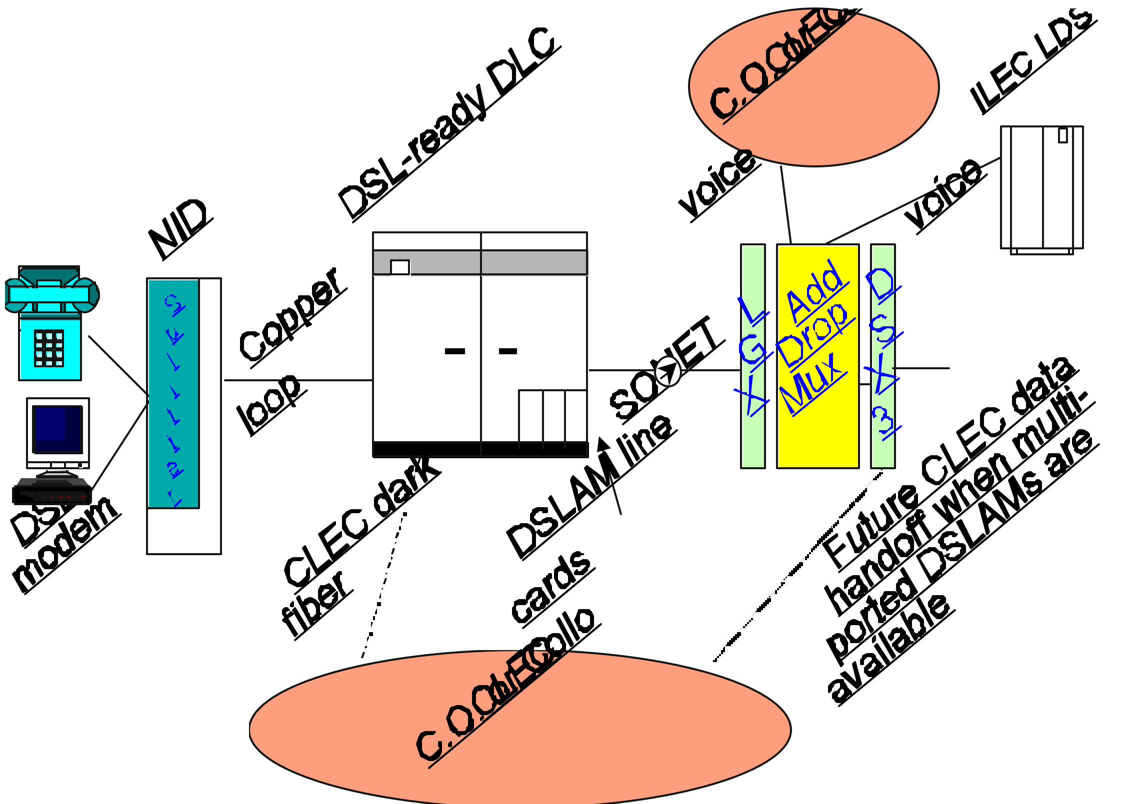

Figure 2 DSL with Digital Loop Carriers (DLC)

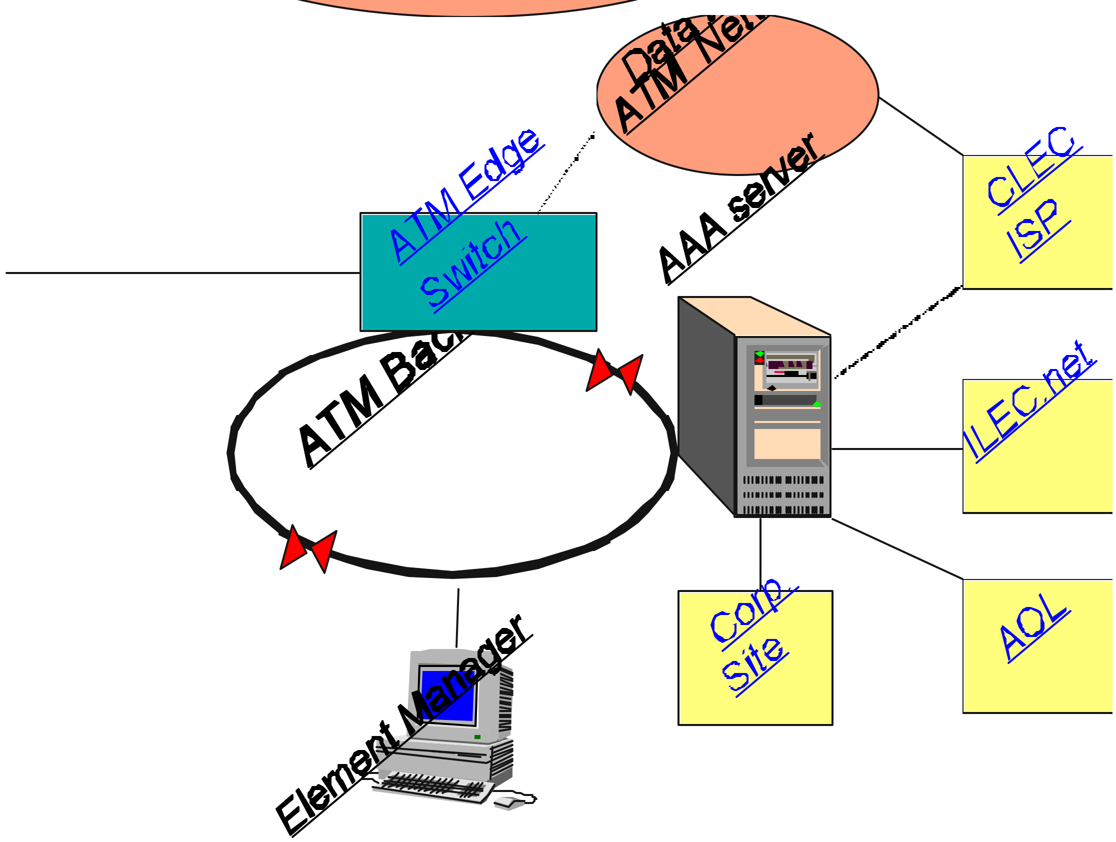

Figure 3 DSL ATM network