TELSTRA CORPORATION LIMITED

ULLS Undertaking

Telstra Efficient Access (TEA) Model Overview

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Contents

A NEED FOR A NEW COSTING TOOL

1. Telstra's PIE II model was first developed in 2001/02. Although the ACCC has used the PIE II model to inform its pricing decisions for various declared services, it has also heavily criticised the model concluding that it cannot be satisfied that the PIE II model is capable of generating reasonable estimates of network costs. In view of this, Telstra has decided to replace PIE II with a new cost model, the Telstra Efficient Access (TEA) model. Compared with PIE II, the TEA model involves substantial advancements in network design, reflects current values for input parameters and engineering design rules and addresses the concerns expressed by the ACCC, particularly those around model usability and transparency.

2. The TEA model is designed for the purpose of estimating the efficient cost of the unconditioned local loop service (ULLS). Because the TEA model focuses exclusively on the cost of ULLS (with the exception of a WLR option), its design is tailored to that service only and therefore has a high degree of reliability and accuracy. The TEA model's singular focus on ULLS also allows the ACCC to direct its attention and resources to the vitally important issue of ULLS costing and pricing without being diverted by costing issues associated with other services. This should promote expeditious resolution of ULLS related issues and thereby limit the duration of pricing uncertainty in the marketplace relating to this service.

3. A primary advantage of the TEA model lies in its flexibility. The model can be run with any set of inputs chosen by the user and at any level of disaggregation. Specifically, the model can be run at the level of individual ESAs, a group of ESAs or all ESAs. Consequently, the ACCC and its staff can run the model with inputs of their choice and do not have to rely on Telstra's selection of inputs and presentation of costs. Further, the model's user interface simplifies the process of determining the sensitivity or cost effects of different inputs and assumptions. This will permit the ACCC and interested parties to identify the issues that are of material consequence and thereby narrow the debate to a limited, manageable number of inputs and assumptions.

4. Telstra will be submitting the full set of inputs and other cost parameters it advocates for determining the costs of the ULLS, along with supporting evidence. Other interested parties are likely to make similar submissions, and Telstra welcomes the opportunity for mutual exchanges of information and a full examination of all relevant issues.

B THE SCOPE OF THE TEA MODEL

5. Because of the importance of ULLS in the marketplace, Telstra's desire is to initiate an examination of the costs of this service as expeditiously as possible. That desire underlies Telstra's decision to proceed with an initial release of a cost model that focuses only on ULLS. The model's limited scope will allow the ACCC to reach pricing decisions for ULLS without being required to expend time reviewing a multi-purpose cost model for services other than ULLS.

6. While ULLS is specifically defined as an unconditioned, copper local loop between the customer premise and an access seeker's point of interface (currently at Telstra exchange buildings), the technologies most relevant or appropriate for other components of the public switched telephone network (PSTN) are still the subject of disagreement within the industry. These definitional debates, which are often driven by issues relating to the timing and evolution of next generation networking (e.g., fibre to the node), can generate substantial disagreement concerning the proper structure and design of a cost model. An advantage of the TEA model is that it is unencumbered by these issues, since there is no dispute concerning the proper definition of the ULLS.

7. In a further effort to expedite ACCC approval of ULLS prices, Telstra has, in its initial submission, decided to narrow the focus of its ULLS costing analysis and pricing proposal to the primary market for ULLS, Band 2 exchanges. This narrow geographic focus should avoid disputes over the appropriate level of averaging, permitting the ACCC and the interested parties to devote full attention to the costs of ULLS.

C THE CORE CHARACTERISTICS OF THE TEA MODEL

8. In an effort to confine the costing debate to disputes over input parameters rather than disagreements over models, Telstra has designed a user interface to facilitate quantifying the effect of changing key inputs on the modelled results. The value of this important feature is advanced by the following key characteristics of the model.

   a. Flexibility – the TEA model offers a wide range of user-generated input parameters.

   b. Transparency – the TEA model provides a clearly delineated methodology and readily discernable calculations, allowing for easy validation of results.

   c. Ease of Use – the TEA model relies upon simple Excel spreadsheets and includes an easily operated user interface. It therefore accommodates a wide range of users from those who want to adjust key inputs and view results to those who wish to interrogate the detailed formulas underlying the individual modules of the model.

   d. Fact-Based Calculations – the TEA model incorporates actual data reflective of real demographic, geographic and topological characteristics of the relevant market including actual customer locations, actual pillar and exchange locations and actual cable routes.

   e. Forward-looking – the TEA model creates a network designed with perfect foresight, meaning that it does not include cost additions associated with legacy networks, such as the costs of capacity reinforcements and stranded network facilities.

   f. Efficiency – the TEA model incorporates forward-looking, best-in-use technology and efficient route designs that minimize distances of ULLS facilities.

   g. Scope and Scale – the TEA model accounts for the advantages of scope and scale that a universal service provider enjoys.

   h. Disaggregated results – the TEA model possesses the capability to view results for discrete geographic regions down to the level of individual exchanges.

   i. TSLRIC+ Methodology – the TEA model embodies sound economic theory and is consistent with the Commission's pricing principles for ULLS.

   j. Accuracy – the TEA model uses actual data for every exchange and therefore does not need to rely upon sampling techniques.

D THE TEA MODEL'S NETWORK DESIGN

9. The model estimates the cost a new entrant would incur to supply the ULLS product. Since ULLS is provisioned over the Customer Access Network (CAN) and defined as unconditioned copper facilities, the TEA model estimates the cost of a forward-looking, replacement CAN comprised of unconditioned copper facilities. The model is based upon real data; it utilises the actual locations of customers, pillars and exchange buildings. Actual customer and pillar locations are used in the model to permit accurate, realistic estimates of today's forward-looking costs. The use of real customer and pillar locations also ensures that the model will continue to be valid and viable as the PSTN evolves into a next generation network.

10. Historically, the ACCC has adopted a scorched node approach rather than a scorched earth approach in replacement network design for cost modelling purposes, which recognises that the existing network infrastructure of telecommunications companies reflects the most realistic form of routing for modelling purposes.[1] Appropriate recognition of existing PSTN infrastructure has been the rationale for keeping existing exchange building locations fixed in cost model design. Exchange buildings have been the bedrock of the public switched network; and it was envisioned that they would remain the bedrock as competitive networks were constructed and interconnected with the PSTN. For many years, this hypothesis has proved out; exchange buildings became primary hubs for competitive interconnection.

11. However, in recent years, as public switched networks and competitive networks have evolved worldwide, it has become abundantly clear that the last mile copper loop, not the exchange building, is the bedrock portion of the existing network that will be carried forward as an integral part of the next generation network (NGN). In the NGN, DSLAMs (and/or their successors) will be placed next to pillars; and these "nodes" will be connected, via fibre, to Ethernet Aggregation Nodes and, ultimately, to soft switches. Exchange buildings will no longer form the backbone of the PSTN; in fact, many will be bypassed and abandoned. Consequently, the TEA model design appropriately treats the last mile of copper as the backbone and bedrock of the PSTN, so that as the rest of the network evolves to NGN, and is scorched, the model will reflect the changing environment.

E THE TEA MODEL'S TSLRIC+ METHODOLOGY

12. In developing the model, Telstra has followed the ACCC's Pricing Guidelines. The TEA model is a Total Service Long Run Incremental Cost (TSLRIC) model which estimates the efficient cost of replacing the CAN using forward-looking, best practices engineering standards and placement procedures and best-in-use equipment. The cost of provisioning the ULLS network is based solely on the equipment needed to satisfy the product definition specified by the ACCC in its declaration of the service.

13. As a TSLRIC+ model, the TEA model estimates the annual incremental or additional cost the firm incurs in the long run in providing the CAN, assuming all of the firm's other production activities remain unchanged. The model is "long run" because all factors of production are treated as variable.

14. The model is *forward-looking*. The TEA model estimates the cost of a replacement network provisioned with best-in-use equipment and efficient, best-practices engineering

[1] The ACCC state that "*in practice the ACCC has tended to take a 'scorched node' forward-looking approach using best-in-use technology. This amounts to a hybrid approach which combines the best technology currently available commercially with the existing network infrastructure*" – ACCC (2002), *The Pricing of Unconditioned Local Loop Services (ULLS): Final Report*, March 2002, at page 16.

standards, construction techniques and placement practices and procedures. The equipment, engineering standards and placement practices are those currently employed by Telstra in new construction and are specified in the Access Network Dimensioning Rules document.

15. Although Telstra currently deploys only fibre main cable in new construction, equipment choices employed in the ULLS version of the model are limited to those that satisfy the ULLS product definition (i.e., an all copper unconditioned loop). Consequently, the model does not use fibre because fibre does not conform to the definition of ULLS. Distribution areas of the existing Telstra network that are fed by fibre are not modelled because ULLS service is not available in those areas. The sharing of trenching and conduit between Fibre Main Cable and Copper Main Cable is accounted for in the model

16. The cost estimates produced by the TEA model follow best-in-use equipment and engineering practices and rely upon placement costs derived from the bids furnished by contractors in Telstra's competitive bidding process. Legacy effects, such as duplicative cable runs inherent in Telstra's current network as a result of the construction and reinforcement of the network over the course of a number of years, are removed from the design of the replacement network. The replacement network design follows best practices and forward-looking provisioning rules, as if the network had been constructed with perfect foresight in a single day. The model only includes costs that an efficient company would incur in building a new CAN.

17. The TEA model follows *attributable* cost concepts[2], as it calculates those costs that can be directly attributed to the production of the service. Production elements used to produce all access lines are shared across all customer access lines. The model also includes a contribution to indirect and common costs, resulting in a TSLRIC+ methodology.[3]

F OVERVIEW OF THE TEA MODELLING PROCESS

18. The TEA model employs engineering design criteria that are based upon actual Telstra records, adjusted as needed to ensure consistency with the forward-looking methodology. The TEA model is founded upon, incorporates, and in all ways reflects sound engineering standards. All *customer locations* used in the model are actual, precise, geographic locations. All *structure points* used in the model (e.g. pits, manholes and pillars) are also actual, precise geographic locations, which are either on a customer's premise or in a legal right of way close to the customer's premise. All *cable routes* (distribution and main) in the TEA model traverse legal rights of way and efficiently connect real structure points associated with real customer locations to actual pillars and exchange buildings in Telstra's network. All distribution and main cable *route lengths* in the TEA model are precisely measured, to exacting engineering standards, through a meticulous process using data resident in Telstra's engineering database, which is the same database Telstra's engineers use to operate, maintain, upgrade and expand the public switched telephone network.

19. The TEA model uniquely incorporates demographic, topological and infrastructure characteristics of an exchange service area to accurately and efficiently design a replacement CAN. The modelling process, described below, begins with data extracted from Telstra's engineering records. Current network records precisely locate a network serving structure point for every address in an exchange either on customer premises, in the case of building terminals, or in the legal right-of-way in close proximity to the customer's premise. Next, the model precisely identifies network capacity requirements

[2] ACCC (2002), *The Pricing of Unconditioned Local Loop Services (ULLS): Final Report*, March 2002, at page15.
[3] ACCC (2002), *The Pricing of Unconditioned Local Loop Services (ULLS): Final Report*, March 2002, at page 16.

at these specific geographic points in an exchange area. Further, the model considers the actual location of roads and rights of way as it designs efficient cable routes to meet the capacity requirements.

20. The methodology produces an efficient design. Rather than model existing cable routes, which unavoidably include the inherent legacy impacts of a network constructed and reinforced over decades, the methodology uses distance minimization techniques to provision an efficient set of routes for serving the existing addresses within the service area. The new replacement CAN is designed, as if one has perfect foresight, to provide the correct amount of capacity required at every point in the network and to follow a single set of efficient cable routes to connect each and every end user back to the exchange building. This method does not rely upon sampling techniques or other simplifying assumptions. Every exchange in Band 2 has been modelled using these specific procedures.

21. This revolutionary methodology provides two important advantages. First, cable routes are located within legal rights of way, an essential component of producing a realistic engineering design. Second, this methodology allows for accurate measurement of route distances between geographic locations from actual engineering records.

G MODEL COMPONENTS

G.1 BASE DATA

22. The base data that feed the TEA model are compiled from actual engineering records for all exchanges in Band 2 (as defined in the undertaking). Every exchange is modelled individually instead of based on less accurate sampling; and the data for every exchange includes the actual location of all end users and all network structures. The processes described in this document for a single exchange, the Blackburn ESA in Melbourne, Victoria, are replicated in the TEA model for 583 Band 2 exchanges.

23. A crucial feature of the modelling process is the ability to identify and select efficient distribution and main cable routes that minimize distance, from all existing CAN routes. In the distribution network, only routes necessary to connect network serving structure points to pillars are identified and selected. Further, when multiple routes are identified, only the route that minimizes distance is selected. Likewise, in the main network, only routes necessary to connect pillars and main-fed building terminals to the exchange building are identified and selected; and, when multiple routes are identified, only the route which minimizes distance is selected. Consequently, the routes that would not be deployed today, given the opportunity to replace the network from scratch, have not been included in the TEA model.

24. Two Telstra Databases have been used in the compilation of base data.

    - The Cable Plant Records database stores Telstra's records of physical cables and shows how the cables/cable sections are jointed to form Telstra's physical network. The data include the geographic locations of the cable routes, and the names/locations of all pits, manholes, poles or building terminals the cables utilise. The cable plant records database also contains all addresses (properties), and geographic locations of those addresses.

    - The Network Plant Assignment and Management system stores the customer services and the network plant interconnectivity to provide a service.

25. Data for the Blackburn ESA was extracted from these databases to compile:

    a. A listing of the size and geographic location of network components:

- Exchange building
- Cabinet
- Pillar
- Building terminal
- Manhole
- Pit
- Pole mounted terminal
- Conduit segment
- Cable – conduit, buried and aerial
- Fibre
- Fibre-fed multiplexers
- Pair gain device
- Commercial lead-in

b. A listing of Service and Demand Information:

   - Customer and potential customer addresses
   - Geographic locations of all addresses
   - Addresses served by building terminals
   - Services in operation for each pillar, cabinet and exchange

c. Identification of Routing Information:

   - Network serving structure points
   - Efficient distribution and main cable routes
   - Lengths of conduit segments and distances between structure points

G.2 THE TEA MODEL'S ENGINEERING MODULES

26. The TEA model contains two engineering Excel spreadsheets, a distribution engineering module and a main engineering module. Both engineering modules utilise the base data and the guidelines specified in the Access Network Dimensioning Rules to determine the types and quantities of all network components required to provision a new, efficient replacement CAN for the Blackburn ESA.

27. The distribution module provisions a new, efficient replacement distribution network along the distribution routes identified in the base data compilation process, beginning from the extremities of each route and accumulating demand back towards the pillar.

Using network capacity requirements calculated for each point of demand and the dimensioning rules specified in the Access Network Dimensioning Rules, the distribution engineering module designs conduit and cable routes along the efficient paths back to the pillar, with each segment appropriately sized. The length of each conduit segment is recorded; conduit route lengths are quantified; and, ultimately total conduit route lengths are aggregated by size of conduit by exchange. Similarly the aggregate length of each cable size is quantified and aggregated by exchange. Quantities for all other necessary components of the network (e.g., equipment, structures and installation functions) are also quantified and aggregated by exchange. The output of the distribution engineering module is a compilation of the total quantity of each network component required to provision a new, efficient replacement distribution network for the Blackburn ESA, including a quantification of all placement functions.

28. The main engineering module provisions a new, efficient replacement main network, which connects every pillar in the Blackburn ESA to the exchange building along the main cable routes identified in the base data compilation process. Using the actual in-service demand at each pillar and the dimensioning rules specified in the Access Network Dimensioning Rules, the main engineering module designs conduit and cable routes along the efficient path back to the exchange, with each segment appropriately sized to meet demand. The length of each segment is precisely identified and recorded and the aggregate length of each size conduit run is compiled by exchange. Similarly the aggregate length of each cable size is compiled and aggregated by Exchange. In like manner, all other necessary network components (e.g., equipment, structures and installation functions) are itemized and compiled by exchange. The output of the Main engineering module is a compilation of the total quantity of each network component needed to provision a new, efficient main network for an exchange, including a quantification of all placement functions.

G.3 THE TEA MODEL'S COSTING MODULE

29. The costing module is an Excel spreadsheet that calculates the total investment required to construct a new, efficient replacement CAN. The costing module uses the cost input variables to develop an average unit cost for every network component (e.g., equipment, structure and placement function) identified in the engineering modules. These composite costs could be the total for a specific piece of equipment (e.g., pillars, pits, manholes) or a unitized cost per metre (e.g., cable or conduit runs), or a cost per function (e.g., joining cables). These average unitized costs are applied to the quantities generated by the engineering modules to develop total investments required to construct a new, efficient replacement CAN for the Blackburn ESA. The investment costs are converted to a cost per line using the network demand from the engineering modules.

30. The costing module then calculates the annual capital costs associated with the investments and calculates an estimate of the annual expenses necessary to operate the new, efficient replacement CAN. The module uses generally accepted accounting principles and tax laws to calculate capital costs and expenses from user-generated financial parameter inputs and expense factor inputs.

G.4 THE TEA MODEL'S USER INTERFACE

31. The user interface is designed to simplify the running of the various modules in the model. It allows users to create and save their own individualised input files, create and run scenarios and generate output reports.

G.5 INPUT VARIABLES

32. The model contains an extensive list of user input variables. The inputs fall into four basic categories:

a. Network design inputs used by the main and distribution engineering modules in determining the sizes and quantities of each network component in a replacement CAN;

b. Equipment and placement prices used in the costing module to quantify the cost of the various network components identified in the engineering modules;

c. Application ratios that identify the percentage of instances of different types of terrain that are encountered; and

d. Capital cost inputs and expense factors used in annual cost calculations.

33. The rules and construction parameters used to quantify and size the network components required to efficiently provide access service are contained in the Access Network Dimensioning Rules document. Many of these network dimensioning parameters have been built into the model as user input variables. The inputs parameters also allow the user to select a tapered or non-tapered distribution cable design.

34. The vast majority of price inputs for the equipment, materials, supplies and contract labour required to construct a replacement CAN are variable.

35. Application ratios are designed to account for variations in terrain in which plant will be placed (i.e., in rocky or normal terrain, turf or under roads, footpaths and driveways).

36. The capital cost inputs are the rate of return on equity, the cost of debt, the capital structure ratios and the average depreciable life for each category of asset used in the TEA model. The expense inputs consist of factors to derive annual costs for:

- Direct expenses (e.g. maintenance, product management);
- Indirect expenses (e.g. information technologies, accounting);
- Network assets (e.g. network buildings, power systems); and
- Indirect assets (e.g. buildings, computer systems).

37. The input list provides a user with maximum flexibility and ease of use. The four categories of inputs identified above allow users of the model to adjust the preponderance of critical parameters used in calculating the replacement CAN costs.

G.6 THE TEA MODEL'S NETWORK PROVISIONING PROCESS

38. The provisioning process in the model accounts for the unique demographic, topological and infrastructure characteristics of the Blackburn ESA. Demographic data is utilised to accurately quantify the capacity requirements of a replacement CAN and specific geographic coordinates are utilised to precisely design efficient, real-world cable routes for the replacement CAN capable of serving every address in Blackburn. A step-by-step description of the provisioning process for the new, efficient replacement CAN is set out below.

G.6.1 Base Data Extraction and Compilation Process - Steps 1 through 3

Step 1:

39. The geographic location of every residential and commercial building in Blackburn is examined and each address is assigned a network serving structure point – a real

structure point in the current network. The lead-in to every property originates or, in the case of building terminals, terminates at its assigned network serving structure point, which is either located on a customer's premises or located in the right-of way in close proximity to the customer's premises.

40. The network serving structure points in the current network are used for two purposes. First, they are signposts used in designing efficient cable routes in the replacement network (rather than being used to recreate in the model the network as currently deployed). Second, they enable precise accurate measurement of route lengths.

Step 2:

41. The geographic locations of all network serving structure points are used to design distribution routes for the replacement CAN which efficiently serve those structure points. For every distribution area in the Blackburn ESA, all of Telstra's existing distribution cable routes are examined to select a single, efficient set of distribution cable routes, which minimizes trench lengths and connects every network serving structure point, and concomitantly every building address, in each distribution area to the pillar serving that distribution area.

42. In like manner, all of Telstra's existing main cable routes in the Blackburn ESA are examined to select a single, efficient set of main cable routes for the replacement CAN, which minimizes trench lengths and connects every pillar in the exchange to the exchange building.

Step 3:

43. The length of every conduit segment connecting network serving structure points in the newly designed, efficient replacement CAN in the Blackburn ESA is extracted from Telstra engineering records and recorded in a table.

G.6.2 Engineering Modules - Steps 4 through 7

Step 4

44. The distribution engineering module uses the following algorithm to calculate distribution network capacity requirements for each of the network serving structure points identified in Step 1. If an address or set of addresses is served by a building terminal, the network capacity requirement at the network serving structure point serving that address, or those addresses, is set equal to the capacity of the building terminal. If an address is not served by a building terminal, the network capacity requirement for the network serving structure point associated with that property is set at one pair for every address assigned to the structure point. The net result is that the distribution network is sized with one pair of capacity per address, unless a building terminal is present.

Step 5

45. The distribution engineering module, following the guidelines set forth in the Access Network Dimensioning Rules, uses the network capacity requirement at each serving structure point to calculate the precise amount of conduit and cable required at every structure point along the efficient distribution cable routes identified in Step 2. The precision of the data compiled and calculated in Steps 1-4 allows the module to provision the new, efficient replacement distribution network with the exact capacity required to provide access to all addresses in the Blackburn ESA.

Step 6

46. The main engineering module, following the guidelines set forth in the Access Network Dimensioning Rules, provisions a replacement main cable network of the exact size needed to efficiently meet the capacity requirements of every pillar in the Blackburn ESA. The capacity requirement of each pillar is set equal to the current number of services in operation served by the pillar.

Step 7

47. The engineering modules calculate the total amount of trenching, labour and equipment necessary to construct the replacement CAN for the Blackburn ESA.

G.6.3 Costing Module - Step 8

Step 8

48. The costing module calculates the total investment, annual capital cost, operating expense and indirect costs needed to construct and operate the replacement CAN.

49. These steps are replicated for every band 2 exchange.