Supplemental Deliverable: Option 4 Evaluation

Ameren

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1. Executive Summary

1.1 Objectives

This supplemental report evaluates a fourth option for the Illinois Statewide Transport. Option No. 4 is basically to retain the existing architecture and primarily perform an equipment replacement in each of the four independent networks:

- Analog microwave
- Timeplex
- Codex
- SONET

The networks should be integrated together as it can be justified cost-effective to do so.

1.2 Cost Estimate by Phase for Option 4

1.2.1 CAPEX

As shown in Figure 1-1, the overall CAPEX cost of Option 4 (minus the detailed design) is **$26,070,250**. This cost does include the overall engineering and oversight cost of *$3,200,000*.

Phase costs are associated with the complete replacements of existing analog baseband rings to minimize analog-to-digital conversions during implementation. Attachment 6 shows a map of the implementation by phase.

Figure 1-1: Summary of Costs for Option 4 Alternative

	RF & MUX	*Antenna System*	*Tower & facility Works*	*SONET & Fiber*	**Total Cost Sites**	**RF Engineering & Freq. Coord.**	**Contingency & Misc**	**Total**
Phase 1: DNX East+SONET	$1,113,368	$51,407	$522,450	$463,644	**$2,150,868**	$27,582	$111,337	*$2,289,787*
Phase 2: West BB Ring+DNX North	$3,475,967	$819,572	$1,886,948	$375,516	**$6,558,002**	$159,572	$347,597	*$7,065,171*
Phase 3: Main BB Ring	$4,616,792	$1,083,370	$3,128,416	$0	**$8,828,578**	$241,094	$461,679	*$9,531,351*
Phase 4: North BB Ring+DNX South	$1,695,210	$202,440	$365,715	$0	**$2,263,365**	$89,740	$169,521	*$2,522,626*
Phase 5: Single Thread m/w	$1,101,977	$56,840	$133,120	$0	**$1,291,937**	$59,180	$110,198	*$1,461,315*
TOTALS	$12,003,314	$2,213,628	$6,036,648	$839,160	**$21,092,750**	**$577,168**	**$1,200,331**	**$22,870,250**
% of total site costs	56.9%	10.5%	28.6%	4.0%			project management and planning	$3,200,000
							TOTAL COST-CAPEX	**$26,070,250**
Recurring O&M Costs (5% of RF & Mux and SONET & Fiber equipment)							Detailed Design	$735,000
TOTAL RECURRING YEARLY O&M	**$642,124**						**TOTAL COST**	**$26,805,250**

1.2.2 OPEX

Recurring OPEX costs consists of two key components:

- Yearly O&M on the installed capital equipment. This is calculated to be **$642,124**. The O&M cost consists of 2 parts: (1) labor requirements, and (2) spare parts provisioning:

  a) Labor requirements: estimated to be a yearly cost of $3,000 per microwave path x 95 paths = **$285,000**. This equates to 3 to 4 full time equivalents.

  b) Spare Parts: estimated to be **$357,124** (2.8% of RF & mux, fiber & SONET costs)

  This estimate is assumed to remain constant throughout the useful life of the equipment, balanced out by less maintenance requirements in the beginning, and increasing in later years as the equipment ages.

- Recurring monthly lease costs of T1s, T3, and OC-3 circuits. Based on the new T1 connectivity for WAN and operational circuits, the current $2.2 million yearly budget has been reduced to **$2.185 million**, as discussed in Section 4.2.3.

Therefore total recurring yearly costs for Option 4 are the sum of the O&M and recurring leased costs: $642,124 + $2,185,000 = **$2,827,124**. For comparison with the current system, O&M labor is considered to be a common cost and subtracted out, resulting in a net OPEX for comparison of $2,542,124.

1.3 Comparison of Option 4 With Other Alternative Attributes and Costs

Figure 1-2 shows a dashboard summary of the key attributes and costs of each alternative, compared with the current transport system.

Figure 1-2: Alternative Attribute and Cost Comparison

Key Objectives of Transport Network	Current System	Primary Lease	Hybrid Own	Total Owned	Option 4
System reliability	◑	○	◑	●	○
Mitigation of future facility replacement risks	na	◑	●	●	◑
Capability of meeting NERC requirements	○	○	◑	●	○
Ability to accommodate future smart grid requirements	●	○	◑	●	◑
Provide secure data paths from end-to-end	●	○	○	●	◑
Overall flexibility to accommodate changing requirements	●	◑	◑	◑	◑
Simplicity of ongoing operations	●	○	◑	◑	◑
Ease of Implementation	na	◑	◑	○	◑
Ease of migration toward total owned solution	●	◑	○	●	●
CAPEX	**na**	**$29,347,607**	**$35,650,183**	**$53,004,630**	**$26,070,250**
Yearly Recurring OPEX (NOTE 1)	**$2,200,000 (NOTE 2)**	**$4,201,588 (NOTE 3)**	**$4,027,588 (NOTE 3)**	**$655,643 (NOTE 3)**	**$2,542,124 (NOTE 4)**

Legend
- ● Excellent
- ◑ Very good
- ○ Good
- ◑ Fair
- ● Poor

Notes

1. Yearly recurring OPEX includes leased circuit costs + O&M spare parts. For comparison purposes, labor O&M is excluded from all OPEX figures, a common cost based on the assumption that Ameren will utilize existing O&M resources for any alternative.

2. For the current system, yearly spare parts cost is essentially zero, since existing parts inventory is recycled and reused. Therefore, this OPEX cost reflects only leased circuit costs.

3. Yearly recurring OPEX includes leased circuit costs + O&M spare parts.

4. Yearly recurring OPEX includes leased circuit costs that are essentially the current $2.2 million per year + O&M spare parts.

1.3.1 Option 4 Considerations in Comparison with Other Alternatives

- CAPEX costs

  a) Option 4 Includes $1.25 million for enhancement opportunities to (1) add route from Peoria to Bloomington via Excelon's Mackinaw site ($855k), and (2) extending microwave network to Decatur by establishing a path from Moweaqua to Route 51 substation ($395k).

  b) Option 4 CAPEX includes replacement of a third of battery plant associated with new equipment additions at major data aggregation sites that are at the end of or past their useful life. Option 4 *does not* include cost to replace all generators and the two-thirds of battery plant at remaining sites. The other 3 alternatives include costs to replace all generators and battery plant over the course of project implementation.

  c) While the costs of remaining replacement batteries and all generators (total of $5.2 million) are not added to the Option 4 project cost, they are included in the cost/benefit analysis to acknowledge these items must be replaced as a separate project, if not part of this project. The $5.2 million is added after the end of Option 4 phase 5 project implementation, spread over years 6, 7, and 8.

  d) The previous three alternatives budgeted for replacement of buildings that are at the end of their useful life, especially buildings that contain transite material. Option 4 pares down the scope of expenditures for buildings with minimal rehabilitations rather than replacement. (reduction of $1.01 million)

- Attribute Ratings

  e) Option 4 is rated "fair" in the category Mitigation of future facility replacement risks because of the exclusion of replacement battery plants and generators, as explained above.

  f) System reliability: Option 4 has more single thread leased paths to 345kv substations and generation facilities than the other 3 alternatives, just as the current network. The Option 4 private microwave topology has more single points of failure than the other 3 alternatives, similar to the current network. Network reliability of the Corporate WAN T1 circuits are comparable to what is being provided with the current network.

  g) NERC Requirements and secure end-to-end paths: The system reliability issues lowers capability to meet NERC requirements compared to other alternatives. However the private microwave backbone is more secure than the leased network in the Primary Leased and Hybrid Owned alternatives, and provides end-to-end security on at least some sites located on the microwave backbone.

  h) Simplicity of operations, Ease of implementation, and Ease of migration to Total Owned Solution: The establishment of a private network for the backbone transport provides migration and operation simplicity advantages similar to the Total Owned alternative, and implementation advantages similar to the Primary Lease/Hybrid Owned networks of the convenience of coordinating leased facilities.

  i) Ability to accommodate smart grid requirements and Overall flexibility: Implementation of an OC3 backbone provides potential capacity to support requirements, and the widespread locations of microwave sites provide potential access points across the state of Illinois.

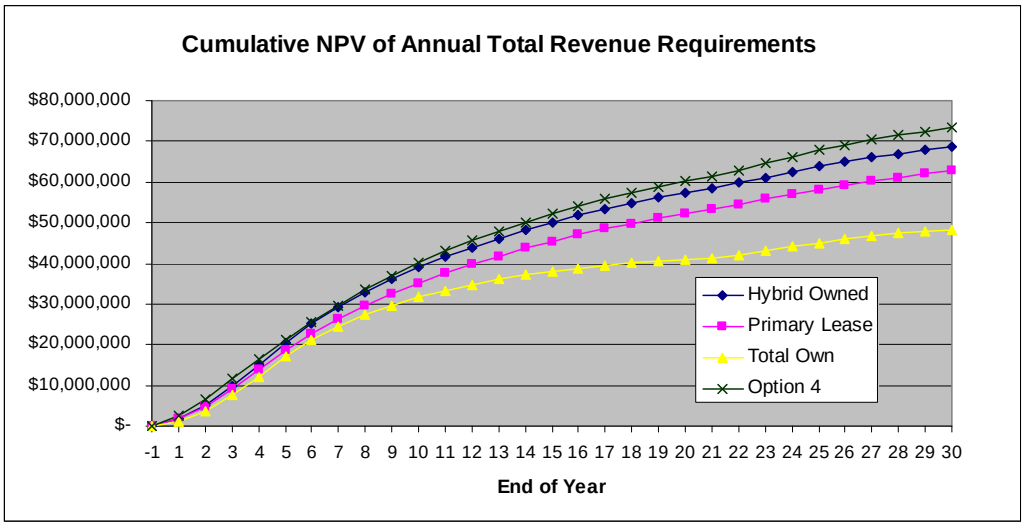
1.4 Evaluation of Alternatives

Figure 1-3 shows the Cumulative NPV of total revenue requirements of Option 4 compared with the previous 3 alternatives.

In the Option 4 case, it can be seen that the cumulative NPV of total revenue requirements generally tracks with the other 3 alternatives for the first 5-6 years, then tracks more with the Hybrid Owned alternative during years 7-11. From years 12-30 Option 4 becomes the worst case. By year 30, Total Cumulative revenue requirements are $73 million, which is above the Hybrid-Owned alternative line at $68.7 million shown in Figure 1-3.

In the long term, the Total Owned alternative still represents the best "value" to the ratepayer in that it requires the least amount of revenue over the analysis period, beating the other alternatives by over $20 million.

Figure 1-3: Option 4 Cumulative Present Worth of Revenue Requirements Compared With Previous Alternatives

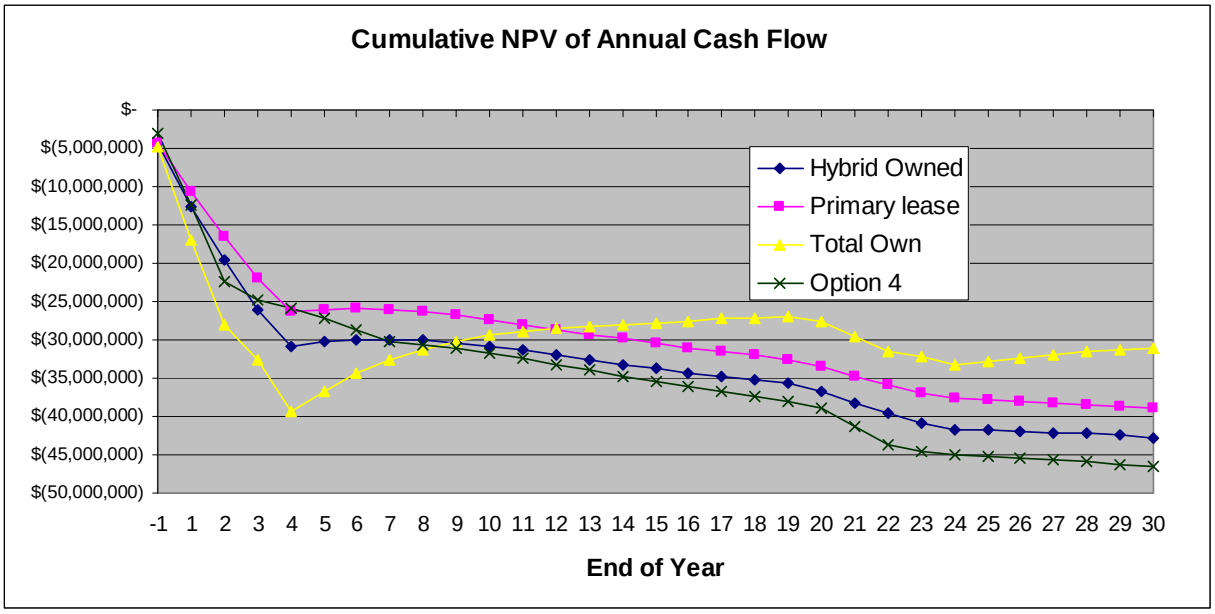


1.4.1.1 Model Results- EVA and NPV of cash Flows for the Three Alternatives

The goal of an alternative is to have a minimally negative EVA and NPV. Figure 1-4 and Figure 1-5 show the NPV and EVA of Option 4 compared with the three previous alternatives.

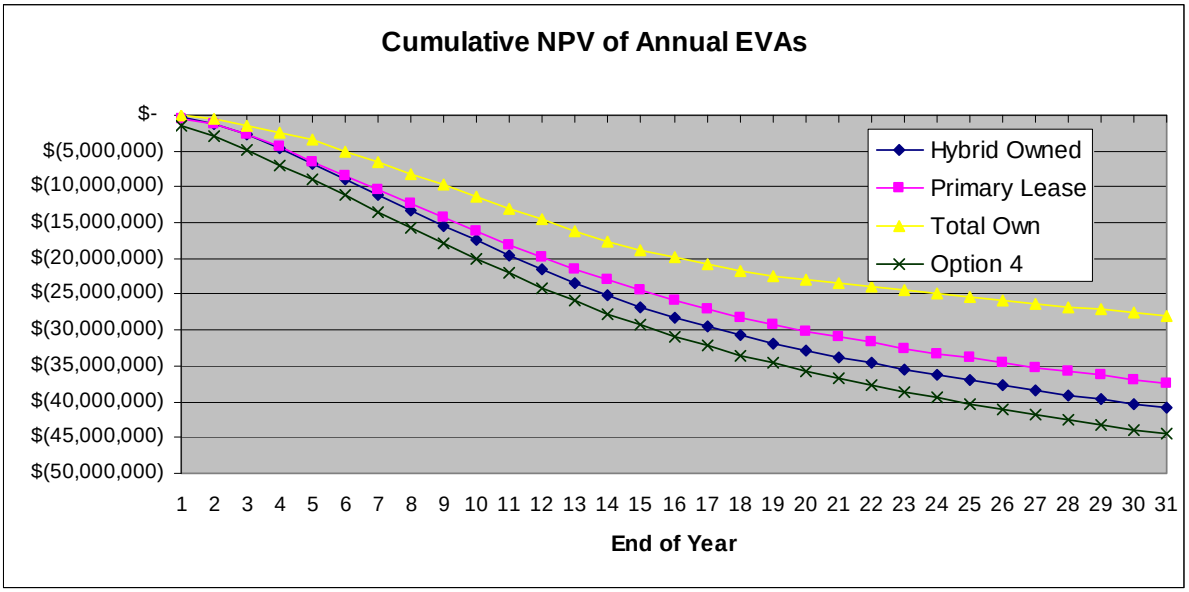
The EVA/NPV/ CPWRR model analyzes these parameters over a 30 year period.

Figure 1-4: NPV of Cash Flow of Option 4 Compared With Previous Three Alternatives



With the NPV cash flow, the Total Owned alternative requires a much greater cash outlay up to year 4 of in-service, but after that begins to gain the returns from revenue and tax benefits, until it becomes more cost effective than the other alternatives, (including Option 4) after 9-12 years. In the near term (less than 6-7 years) Option 4 has a cumulative NPV of cash flow range comparable to the Primary Lease and Hybrid Owned alternatives, but becomes the worst case by year 10, growing to a wider margin by year 30. However, in years 4-5, Option 4 ties the Primary Lease alternative with the least cumulative NPV of annual cash flow.

Figure 1-5: EVA Comparison of Option 4 With Previous Three Alternatives



Over the study period of 30 years for the EVA analysis, the cumulative results continue to be the least negative for the Total Owned alternative. This is aided by the fact that since more capital expenditures are involved that can draw a return on investment, along with recurring expense that are more than a factor of 2 less than the other alternatives, a greater future value is provided to the Company. Similarly, the Total Owned alternative has the least negative cumulative EVA/NPV over the total 30 year period. The Primary Lease and Hybrid Owned alternatives follow similar curves from years 4 to 8 onward, basically spaced by the difference in capital expenditures required. Option 4 is the worst case EVA all the way through the evaluation period.

1.5 Cost/Benefit Evaluation Dashboard

Figure 1-6 presents a summary of the comparisons of the key operational and financial parameters that is used in the final evaluation and recommendation.

Figure 1-6: Cost/Benefit Evaluation Dashboard

KEY DRIVERS	Current	Primary Lease	Hybrid Own	Total Owned	Option 4
NON-FINANCIAL KEY DRIVERS					
Reliability/Operational Risk	●	○	◑	●	◑
Interoperable Platform to Support Future Smartgrid Architecture	●	○	◑	●	◑
Flexibility/Scaleable To Changing Requirements	●	◑	◑	◑	◑
FINANCIAL KEY DRIVERS					
Short-term Cumulative NPV of Revenue Requirements (8 years)	na	◑	⊘	●	○
Long-term Cumulative NPV of Revenue Requirements (30 years)	na	◑	⊘	●	○
Short-term Cumulative NPV of Cashflow (5 years)	na	●	⊘	○	◑
Long-term Cumulative NPV of Cashflow (30 years)	na	◑	⊘	●	○

Legend
- ● Excellent
- ◑ Very good
- ○ Good
- ◑ Fair
- ● Poor

Legend
- ● Best value NPV
- ◑ Better value NPV
- ⊘ Next to least value NPV
- ○ Least value NPV

1.6 Conclusions and Recommendations

All indicators point to the Total Owned alternative still as providing the best long term value to Ameren. It provides best overall value and benefits to ratepayers, as shown from EVA/NPV/CPWRR model analysis. The Total Owned solution also provides a level of insurance in that it mitigates future risk if NERC tightens requirements on use of leased facilities for communications with critical transmission assets.

Results show that implementing Option 4 has a similar outcome to the Hybrid Owned alternative, but provides less value in total cumulative revenue requirements or cumulative NPV of cash flow in the later years. It does provide the advantage of minimizing CAPEX and OPEX outlay in the early years, and providing a more viable migration path to Total Owned (building a private backbone rather than leased), preferably timed to commence by years 8-10 when results show Total Owned to be the more long term cost-effective solution.

Option 4 would provide a private backbone transport that would be under Ameren control, compared to the Hybrid Owned which relies on a carrier leased fiber transport for primary backhaul. However sites off the private backbone would still be subject to leased facilities in local loops, identified to be an issue from a reliability standpoint.

Overall, the recommendation is to proceed with Option 4 rather than the Hybrid Owned alternative, if the long-term goal is to eventually migrate to the Total Owned solution.

2. Introduction

2.1 Objectives

This supplemental report evaluates a fourth option for the Illinois Statewide Transport. Option No. 4 is basically to retain the existing architecture and primarily perform an equipment replacement in each of the four independent networks:

- Analog microwave
- Timeplex
- Codex
- SONET

The networks should be integrated together as it can be justified cost-effective to do so.

2.2 Key Assumptions for Option 4

Key assumptions that relate to this Option include:

- The primary objective is to replace obsolete and legacy equipment that support the SCADA operational network.
- Corporate WAN traffic will be independent of the operational network, and addressed as a separate budgetary item. If additional capacity should be available after SCADA requirements are accommodated, corporate WAN traffic may use the spare capacity.
- The current levels of reliability should be maintained, and significant additional costs should not be added for increased reliability.
- The network replacement addresses current SCADA traffic requirements, and will not take into account future potential requirements such as automation, video surveillance, or smartgrid.
- The present $2.2 million yearly OPEX costs for leased lines should not be increased.
- Identify opportunities to enhance the equipment replacements when it appears cost-effective to do so.

3. Identification of Requirements to be Supported by Option 4

Option 4 will replace equipment at sites that currently exist with legacy equipment that are part of the four independent networks. A map of the current legacy network that is used as the basis for this equipment replacement is shown in Figure 3-1. The total number of sites that are part of Option 4 total 127, which is reduced from the total 201 sites identified as part of the previous 3 options.

A list of the 127 sites that would be applicable to connection with the Option 4 “baseline” Illinois transport network is shown in Attachment 1. By baseline, it is implied that these sites would be part of the basic architecture for the transport network, and provide access points for potentially hundreds of other Ameren sites or field devices that exist elsewhere off the transport backbone, that may be integrated in the future as considerations for automation (substation, distribution) and smart grid are developed. However capacity is only considered at this time to meet current requirements. Increases in capacity to accommodate future potential requirements will be subject to further review.

Attachment 1 identifies the 127 baseline sites retaining the ring convention developed in the previous alternatives. This nomenclature is retained for initial reference only, and a new nomenclature is developed associated with the implementation phasing, discussed in Section 5**.**

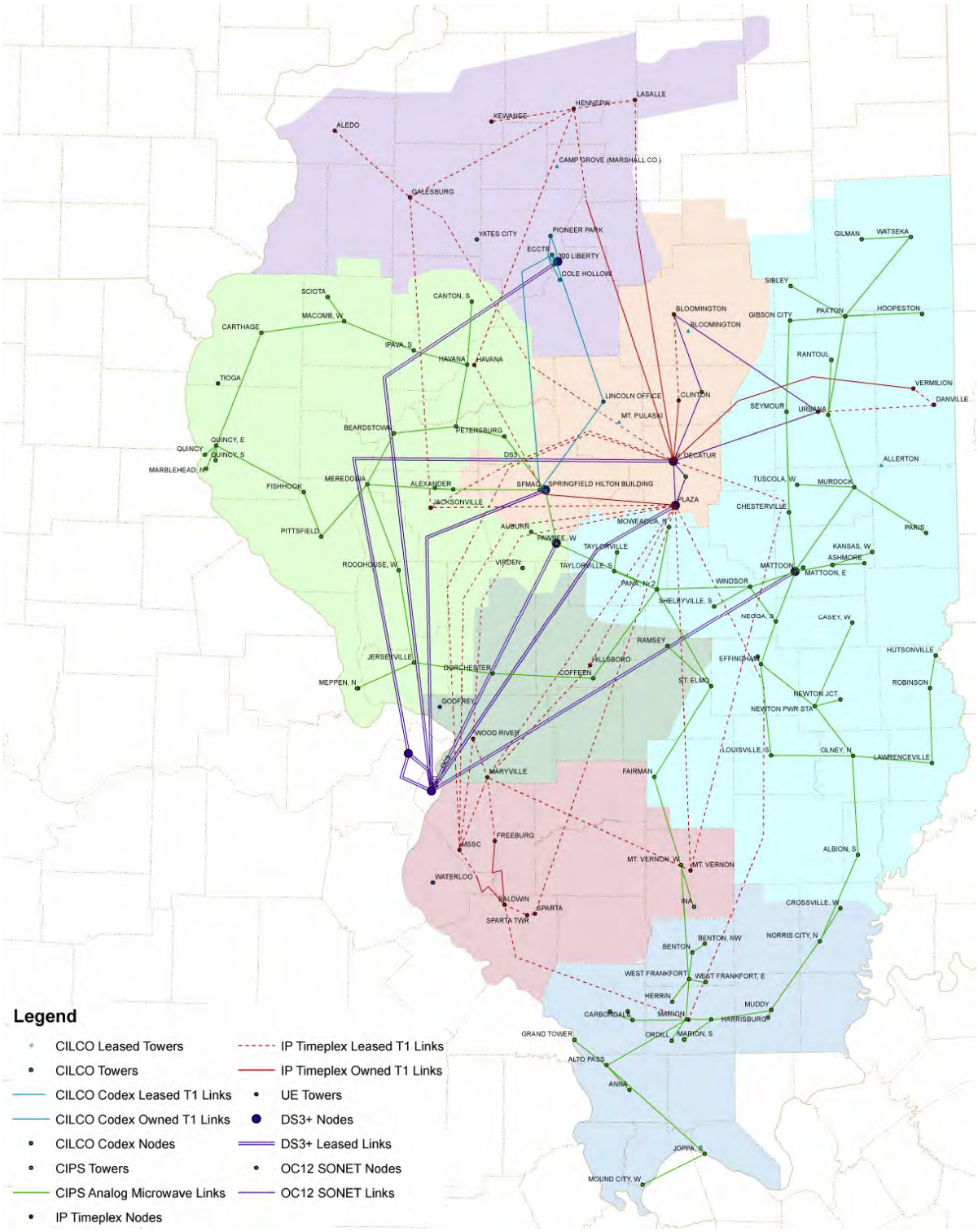
Key network equipment replacements that are identified to be supported by the transport network are discussed in the following sections.

3.1 Key Operational Network Replacements

Presently, the Ameren Illinois telecommunications network consists of 5 relatively independent and dissimilar networks throughout the Illinois territories of CIP, CILCO, and IP. Historically, each operating company has had its own network to support its own needs, which is a limitation now that all these companies are under the Ameren umbrella. The key networks in place include:

<u>90+ node Analog microwave network</u> that consists of Motorola MR600 radios that were initially installed in the early 1970’s, to Motorola Starpoint 6000 narrowband radios that were installed in the early 1990’s. This radio network primarily supports operational needs related to SCADA for mostly transmission substations, but also provides a backhaul for distribution SCADA MAS

Figure 3-1: Illinois Legacy Network Map for Equipment Replacements



networks as well. Some protection relay circuits also ride the system. Both these radios had been manufacture discontinued by the mid 1980's.

Six node Motorola Codex 6250 T1 multiplex system installed in 1993 in association with the mobile trunked radio system. It is also now used to drop DS0s at office and work site locations, supporting voice tie lines and some operational SCADA circuits. It has a maximum capacity of 3 x T1 circuits. Motorola dropped support in the late 1990's, no longer directly offering maintenance and parts. There are a few companies that exist today that offer refurbished parts, but support options are minimal.

20+ node Timeplex Link/2 and Link/100 T1 multiplex system: most of these nodes were installed in the 1993-1997 time frame to support PBX voice, mobile radio, corporate WAN, and some operational data. The new manufacture of these nodes was discontinued in 2006, with common I/O voice and data cards manufactured until April 2007. Timeplex has since gone out of business, transferring all intellectual property to Tangent Communications, a smaller company that specializes in equipment refurbishment and reselling. Most equipment available for these nodes is refurbished, with some level of support that can be expected. However Tangent has indicated this support is committed until 2015. Support may be possible after 2015, but no commitments at this point.

Less than 10 Nortel SONET OC-12 nodes that are currently utilized on the pockets of fiber that are owned by Ameren, or for which Ameren has a right to use. These are primarily in the Champaign, Bloomington, and Decatur areas where the fiber is located. The nodes presently in service were installed in the 1995-1997 time frame, and have been manufacturer discontinued in the last several years. These SONET nodes do not have the "next-generation" SONET capabilities that were developed around the 2003 time frame to enable multi-service SONET platforms.

Leased Line Network: To most of the Ameren offices and generation facilities exist leased facilities of T1 or T3 lines, as well as a leased OC-3 between St. Louis and Decatur. Service is provided by McLeod, Verizon, and AT&T. These support primarily corporate WAN traffic. The T3 and OC-3 lines are protected with redundant paths from POP to POP. Reliability has been cited as a concern at some generation facilities.

3.1.1 Analog Microwave Network

Attachment 2 summarizes the existing microwave paths to be included in the Option 4 evaluation.

Digital upgrades are based on the reference analog microwave systems map contained in Attachment 3. Criteria for radio replacement includes:

- Existing Wideband 480 channel licensed analog radios are replaced with a minimum of DS-3 digital licensed radios (672 channel equivalents), the nearest comparable capacity to the existing analog.
- Lower capacity analog radios (15, 24 channel) are replaced with 8 x T1 capacity licensed digital radios, a T1 increment that can be as cost-effective as lower capacity licensed digital radios
- Existing low capacity spread spectrum and licensed digital radios are also replaced with 8 x T1 capacity licensed digital radios.

Attachment 2 also associates the new digital radios with the existing rings that exist to support the baseband filtering scheme currently used with the analog radios. Three such baseband rings exist: Main, West, and North. West includes all radios West of Pana; North includes all radios North of Mattoon, and the main baseband includes all radios between Pana and Mattoon.

Because of the current baseband filtering schemes and the need to minimize analog-to-digital conversions during implementation, the analog radio replacements are assessed on a full ring basis; that is, each existing analog baseband ring is replaced in its entirety as part of an implementation phase. Single thread microwave links that connect to the rings via audio patch (designated as “AP” in Attachment 3) can be considered separately; extensive analog/digital conversion is not required at these interface points, and can be converted cost-effectively.

3.1.1.1 Traffic Requirements

Each analog baseband ring supports a number of circuits associated with its member sites. Many of these circuits may terminate at DACS, or interface points with leased DS-1 or DS-3 facilities. A cursory review of the multiplex assignment sheets indicate that on the rings, the followings sites serve as aggregation points for a proportional share of traffic:

Site	Approximate no. of circuits terminated
Mattoon	180
Pana #1	37
Springfield	50

Beardstown	40
Marion	40
Joppa	25
West Frankfort	50

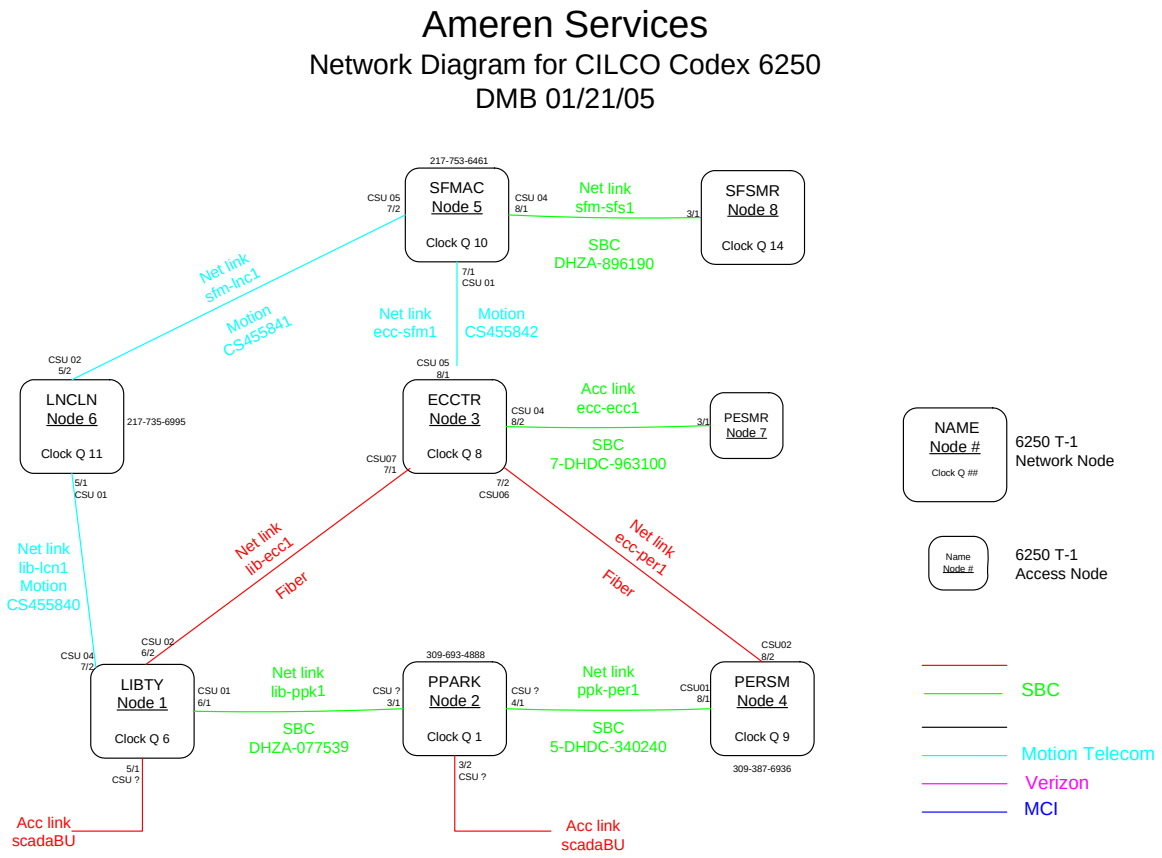
Ultimately, many of these circuits terminate at North Decatur at the DDOS or ESOS control centers, or the St. Louis GOB. They may get to their final destination via leased DS-3s or direct circuits from the aggregation points to the final destination.

With all the potential entry points that will be available on the digital radio network, DACS locations may need to be established at certain radio sites to make more efficient grooming and utilization of T1s on the digital microwave radios. These locations are primarily key radio sites where several radio paths converge and/or leased DS-1 or DS-3 lines from remote DNX locations terminate.

3.1.2 CODEX Network

The CILCO Codex 6250 network as initially established is shown in Figure 3-2**.** It is connected via a combination of leased T1 circuits and private fiber. Sites and paths are summarized in Attachment 2.

Figure 3-2: CODEX Initial Network



The CODEX network has been reduced in size, mainly due to the implementation of the new shared statewide mobile radio network, which reduced the need to terminate mobile radio voice circuits at the CODEX locations. Several SCADA circuits have now also been re-terminated at other locations. The future CODEX replacement network at this time appears to include only the following sites:

Lincoln office: terminates 6xDS0 circuits (1 electric SCADA, 1 gas SCADA, 4 MAS circuits). The new design will include dual-homed leased T1 lines: one T1 to Peoria Liberty, which provides access to a leased DS-3 to GOB and N. Decatur, and one T1 to Bloomington, which provides access to the fiber SONET ring that access N. Decatur and Decatur Plaza.

Peoria Liberty, Peoria ECC, and Peoria Persimmon are all connected via private fiber, and are located only a few city blocks from each other. Connectivity may be retained between these locations as required for other purposes.

3.1.3 Timeplex Network

The IP Timeplex network consists of 26 nodes and connected leased T1 paths as shown in Figure 3-3. The paths are also summarized in Attachment 2.

Presently, operational SCADA circuits may share a leased T1 with PBX voice or Corporate WAN traffic. In the Option 4 design, the operational circuits are split out from the non-operational traffic and will not share T1s with Corporate data. This is consistent with the networks that currently exist for CILCO and CIPS. In essence, separate leased T1s will be established for each service. This is consistent with prudent practices to meet NERC requirements.

Existing leased T1 circuits and associated monthly costs are shown in Table 3-1**.** Currently, the leased T1 network costs about $35,775 per month or **$429,300** per year.

3.1.3.1 Operational Traffic Requirements

The majority of the Timeplex circuits terminate in N. Decatur. Table 3-2 shows a summary traffic matrix of existing operational circuits that need to be accommodated with a Timeplex replacement network.

Several locations drop circuits that require a significant portion of a T1 equivalent, the largest (besides Decatur) being Maryville (32 circuits) and Champaign (31 circuits). Decatur itself drops a total of 205 circuits, with most of the circuits terminating at N. Decatur.

Figure 3-3: Timeplex Nodes and Paths

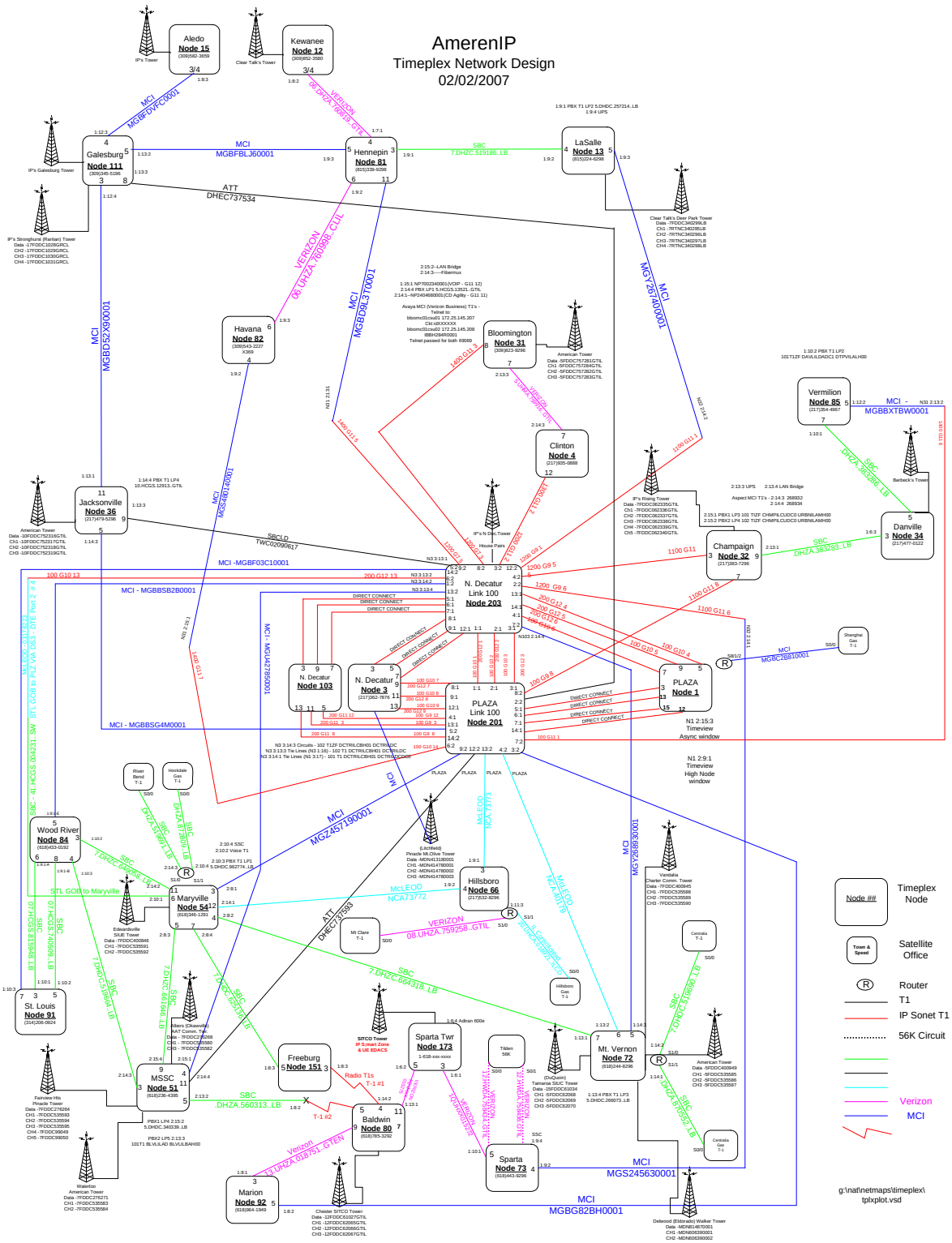


Table 3-1: Monthly recurring T1 Costs-Timeplex Network

Site A	Site B	Notes	Amount Monthly
Galesburg ofc	Hennepin PS		991.23
Galesburg ofc	Decatur Plaza		1,019.60
Galesburg ofc	Jacksonville ofc		998.14
LaSalle ofc	Champaign ofc	To N. Decatur via fiber	885.21
Jacksonville ofc	N. Decatur		680.80
Jacksonville ofc	Decatur Plaza		891.22
Bloomington ofc	Clinton PS	reroute via fiber	481.94
Belleville ofc	N. Decatur		885.21
Belleville ofc	Decatur Plaza		819.26
Belleville ofc	Wood River PS		320.00
Belleville ofc	Maryville ofc		1,064.00
Belleville ofc	Baldwin PS		896.00
Maryville ofc	Mt. Vernon ofc		3,148.00
Maryville ofc	Decatur Plaza		909.21
Maryville ofc	Hillsboro ofc		1,467.46
Wood River PS	N. Decatur		905.21
Sparta ofc	N. Decatur		640.34
Mt. Vernon ofc	Decatur Plaza		1,400.84
Mt. Vernon ofc	N. Decatur		900.21
Marion SIPC	Decatur Plaza		905.21
Hillsboro ofc	Decatur Plaza		620.00
Havana PS	Decatur Plaza		885.22
St. Louis GOB	Wood River PS		358.39
St. Louis GOB	Wood River PS		250.06
St. Louis GOB	N. Decatur	use existing DS-3 &OC-3	813.02
Lincoln ofc	Springfield MAC	CODEX T1	478.63
Galesburg ofc	Aledo Twr		1,000.46
Hennepin PS	Kewanee Twr		729.51
Hennepin PS	Havana PS		825.75
Hennepin PS	N. Decatur	leased T1 to Bloomington then via fiber	991.23
Hennepin PS	LaSalle ofc		618.00
Bloomington ofc	N. Decatur	on fiber	-
Clinton PS	N. Decatur	on fiber	-
Vermilion PS	Decatur Plaza	leased T1 to Bloomington then via fiber	1,624.64
Vermilion PS	Danville Twr		700.00
Danville Twr	Champaign ofc		700.00
Champaign ofc	Decatur Plaza	via fiber	-
Champaign ofc	N. Decatur	via fiber	-
Maryville ofc	Freeburg Gas Field		800.00
Maryville ofc	Wood River PS		1,500.00
Baldwin PS	Marion SIPC		705.50
Baldwin PS	Sparta Twr		846.97
Sparta Twr	Sparta ofc		414.50
Baldwin PS	Freeburg Gas Field	private microwave path	-
Lincoln ofc	Peoria Liberty	CODEX path	704.04
		TOTAL MONTHLY-CURRENT	**35,775.01**

Table 3-2: Timeplex Summary Operational Traffic Matrix

LATA		Decatur Plaza	N. Decatur	N. Decatur #2	St. Louis	Marion	Belleville	Mt. Vernon	*ckt drops at field*
374	Decatur Plaza		**1**		**2**				**3**
374	N. Decatur				**14**				**14**
374	N. Decatur #2				9				**9**
634	Aledo MAS		1						**1**
362	Baldwin PS			3		2	1		**6**
366	Bloomington ofc		7	10	2				**19**
370	Champaign ofc		18	13					**31**
366	Clinton PS			5					**5**
370	Danville Twr		3		1				**4**
520	Freeburg Gas Field	1						1	**2**
977	Galesburg ofc	1	6	8	1				**16**
368	Havana PS		1						**1**
358	Hennepin PS		4	7					**11**
976	Hillsboro ofc		5	5					**10**
376	Jacksonville ofc		1	4					**5**
358	LaSalle ofc		4	7	1				**12**
362	Marion SIPC			2					**2**
520	Maryville ofc	4	12	16					**32**
520	Belleville ofc	1	6	9					**16**
520	Mt. Vernon ofc	1	2	13		1			**17**
362	Sparta ofc		6	5					**11**
362	Sparta Tower			2	10				**12**
370	Vermilion PS		4	1					**5**
520	Wood River PS		13	2	2				**17**
	tot from field	**8**	**94**	**112**	**42**	**3**	**1**	**1**	**261**
			206						**261**

3.1.3.2 WAN Traffic Requirements

With the breakout of the operational traffic from the WAN traffic, Table 3-3 summarizes the T1 connectivity that would be required to continue the support of WAN traffic. This Table shows a reuse of some existing T1 circuits, and adding additional T1 circuits to N. Decatur to accommodate sites that were originally homed to a Timeplex node. The capability to home these T1 circuits to a microwave radio site and utilize the private facilities were evaluated, and is discussed in Section 4.2.3.2.

Table 3-3: T1 Circuit Requirements for WAN Traffic

Site A	Site B	Notes	No. of T1s
EXISTING Timeplex circuits that can be reused and dedicated to Corporate WAN traffic			
Galesburg ofc	Decatur Plaza		1
LaSalle ofc	Champaign ofc	To N. Decatur via fiber	1
Jacksonville ofc	N. Decatur		1
Belleville ofc	Decatur Plaza		1
Maryville ofc	Decatur Plaza		1
Sparta ofc	N. Decatur		1
Mt. Vernon ofc	N. Decatur		1
Hillsboro ofc	Decatur Plaza		1
NEW T1 circuits to be established for dedicated Corporate WAN traffic			
Danville	N. Decatur		1
Shanghai Gas	N. Decatur		1
Hillsboro Gas Field	N. Decatur	**any of these could also be**	1
Hookdale Gas Field	N. Decatur	**terminated at Decatur Plaza**	1
Freeburg Gas Field	N. Decatur	**if more cost effective**	1
Tilden Compressor Station	N. Decatur		1
Centralia Gas Field	N. Decatur		1
Centralia Office	N. Decatur		1
Mt. Claire	N. Decatur		1

3.1.4 Nortel Fiber SONET

The fiber SONET paths consist of OC-12 fiber rings constructed with terminals located at:

- Bloomington
- Clinton
- N. Decatur (2 terminals)
- Decatur Plaza (2 terminals)
- Champaign

The approximate fiber paths are estimated and shown by the heavy blue lines in Figure 3-4**.** All terminal equipment will be direct replacements at their current locations, except for CPS-NSB. The new equipment is to be moved to the CPS switchyard from its present CPS-NSB location.

The SONET sites are potential aggregation points for leased T1 lines, since they can provide direct, protected reliable access to N. Decatur.

N. Decatur and Decatur Plaza are interconnected via fiber and multiple OC-12 systems; this link can allow traffic to enter one location and “transparently” transport to the other as required.

3.1.5 High Capacity Leased Circuits

Currently leased DS-3 circuits exist between the following locations.

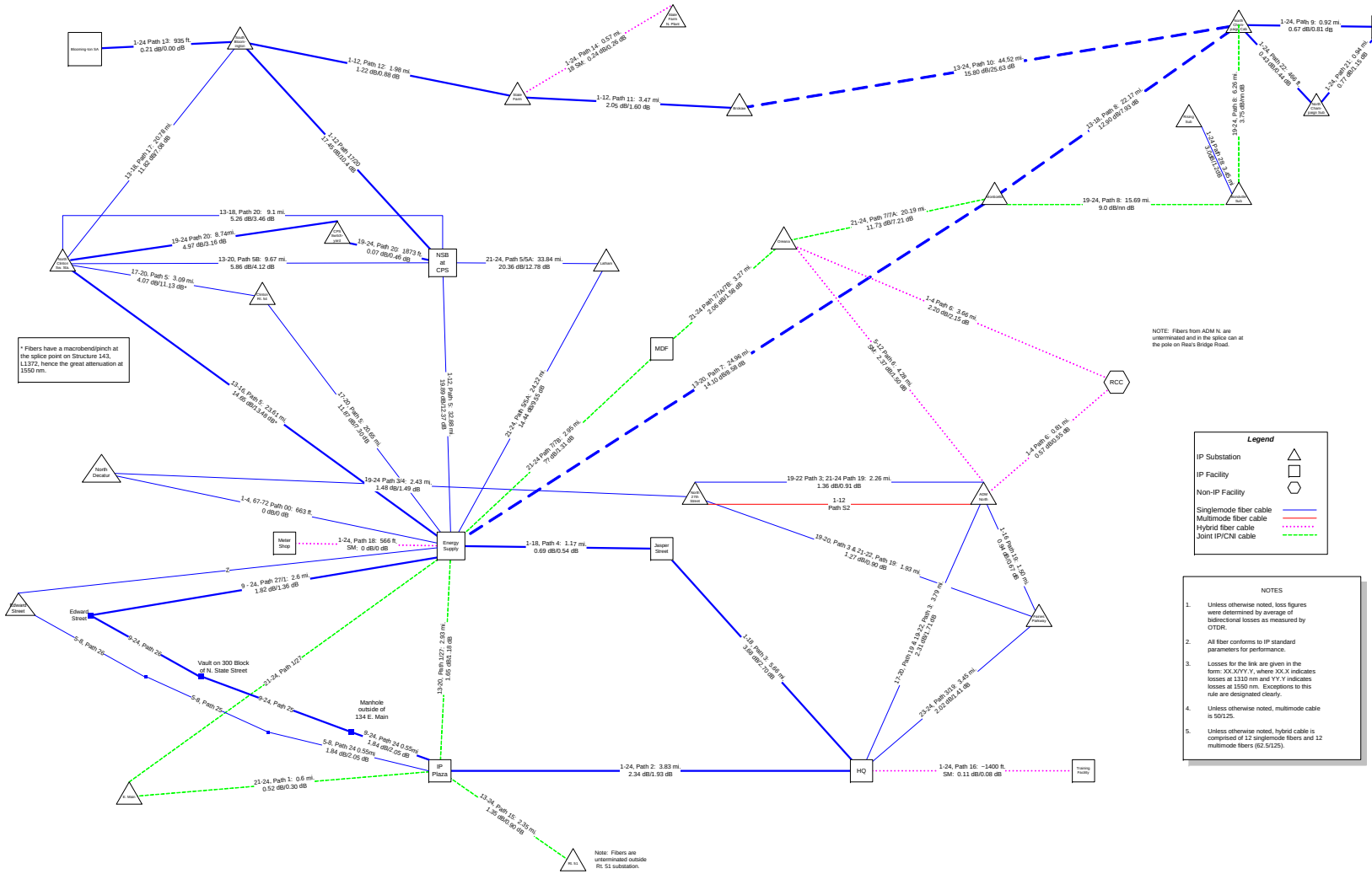
- GOB-N. Decatur
- GOB-Mattoon
- GOB-Springfield
- GOB-Pawnee
- GOB-Peoria Liberty
- Peoria Liberty-N. Decatur
- Springfield-N. Decatur

Option 4 makes use of these DS-3 circuits. Each DS-3 end point is an aggregation point for DS0 and T1 circuits that can be routed to Decatur via GOB, Springfield, or Peoria Liberty.

The Springfield, Pawnee, and Mattoon DS-3 aggregation points are also located convenient to the microwave network, where circuits can be routed from the microwave via the DS-3 circuits to N. Decatur, either direct through Springfield, or through St. Louis GOB.

The leased OC-3 link that currently exists between GOB and Decatur Plaza could also be used as an alternate path to N. Decatur from GOB, depending on the available capacity.

Figure 3-4: Estimated Fiber Paths for SONET



4. Option 4 Implementation Design

4.1 Option 4 Architecture Overview

Option 4 makes use of the existing infrastructure. The primary goal of Option 4 is to mitigate the risk of continued operation with legacy equipment by replacing it before a major failure occurs, resulting in significant downtime. Equipment platforms assumed for the replacement are discussed in the following sections.

4.1.1 Analog Microwave Replacement with Digital Microwave Radio

Harris Truepoint radios are assumed to be used, similar to recent projects that were implemented for Ameren in Missouri. Harris provided costing information for the Missouri project to the KEMA Team, and indicated that the costs would also be applicable to the Illinois project.

4.1.2 Timeplex and CODEX TDM Node Replacement with Sycamore DNX

Two options are considered, depending on the expected traffic:

DNX-1u: With up to eight T1 or E1 short/long haul interfaces, the DNX-1u provides DACS capability for the smaller locations. Eight ports of 10/100 Ethernet connectivity, combined with Layer 2 switching and channelized/unchannelized routing, eliminate additional devices such as hubs, switches, and routers. Two synchronous EIA-530/ITU X.21/V.35 interfaces provide access for Nx56/64 serial data, while six asynchronous EIA-232/ITU V.24 interfaces provide the terminal server functionality required to manage legacy equipment. It has less redundancy options available and costs less than the DNX-11.

DNX-11: The DNX-11 provides DACS capability for the larger locations that are aggregation points for TDM traffic. A DNX-11 would be located at the head of a TDM ring, or at a microwave site that serves as an intersection point for multiple paths. It will also be located at the DS-3 interface points equipped with redundancy to ensure reliable service in support of operational circuits.

Populated with any mix of module sets across 11 slots, the DNX-11 can terminate services from as many as 88 T1/E1s, 6 DS3s, 7 E3s or two OC-3/STM-1s, and has a non-blocking switching capacity of 168 T1/128 E1 equivalents. With the addition of a CPX Module Set, the DNX-11 consolidates circuit/packet processing within a single platform, enabling cost-effective, carrier-grade migration from TDM to IP. The DNX-11 can be configured for AC or DC redundant load-

sharing power supplies, with independent inputs from power distribution panels; and the System Manager Controller (SMC) can be non-redundant or redundant at all levels of operation.

4.1.2.1 Locations Targeted for DNX nodes

All existing Timeplex and CODEX locations will be replaced with DNX or equivalent nodes. Whether it is a DNX-1u or DNX-11 depends on the amount of traffic traversing the node, and the number of T1s that also terminate on the node. Table 4-1 shows the Timeplex and CODEX location replacements with the DNX type.

In addition to the Timeplex and CODEX locations, DACS nodes should also be established at critical junctions on the microwave network to allow efficient cross-connect of DS0s from ring to ring and path to path. DACS nodes would be located at microwave sites that (1) have a DS-3 line termination, (2) have at least 3 or 4 microwave path intersections, or (3) terminate a leased T1 line from a remote DNX site. Table 4-1 also shows the microwave sites that have been budgeted for a DACS, and the type.

Table 4-1: Locations Where DNXs are Budgeted

Timeplex/CODEX replacement Nodes			Microwave Site		
Node	DNX Type (11 or 1u)	Notes	M/w Site	DNX Type (11 or 1u)	Notes
Aledo	n/a	channel bk	Alexander	1u	
Baldwin PS	11		Coffeen	1u	
Bloomington ofc	11		Dorchester	1u	
Champaign ofc	11		Effingham	11	
Clinton PS	1u		Fairman	1u	
Danville Twr	1u		Havana	1u	
Decatur Plaza	11	DS-3 agg	Jerseyville	11	
Freeburg Gas Field	11		Macomb W	11	
Galesburg ofc	11		Marion	11	
Havana PS	1u		Mattoon	11	DS-3 agg
Hennepin PS	11		Meredosia	11	
Hillsboro ofc	1u		Mt Vernon W	1u	
Jacksonville ofc	1u		Olney N	11	
Kewanee Twr	n/a	channel bk	Pana N1	11	
LaSalle ofc	1u		Pawnee	11	DS-3 agg
Lincoln ofc	1u	CODEX repl	Springfield	11	DS-3 agg
Marion SIPC	1u		W Frankfort	11	
Maryville ofc	11				
Belleville ofc	1u				
Mt. Vernon ofc	1u				
N. Decatur	11	DS-3 agg			
Peoria (Liberty)	11	new/DS-3 agg			
Sparta ofc	1u				
Sparta Twr	1u				
St. Louis GOB	11	DS-3 agg			
Vermilion PS	1u				
Wood River PS	11				

Notes
1. DNX is assumed at DS-3 aggregation points as replacement to current mux, for flexibility & redundancy
2. Peoria Liberty not previously a Timeplex location, but will be key aggregation point
3. St. Louis GOB may need to be DNX-88

4.1.3 Fiber SONET Node Replacement

The existing Nortel fiber OC-12 SONET nodes are assumed to be replaced with a similar capacity, from current vendors such as Nortel or Alcatel-Lucent. However the incremental cost of an OC-48 node may be considered as a cost-effective replacement, and would not add significant cost to the project since there are only seven sites to be replaced.

OC-48 vs OC-12 costing is subject to further review. However, for purposes of this initial project budgeting, an OC-48 terminal is assumed to cost approximately twice that of an OC-12 terminal. For costing purposes, the number of OC-12 terminals required at a site has been doubled to allow additional dollars for consideration of an OC-48 terminal.

4.1.4 TDM Multiplex, Switches, Routers

For the most part, the Option 4 design centers on the capability to provide a TDM network for operational traffic. To support this requirement, an RFL IMUX channel bank is assumed to be established at each location, with redundancy and drop-and-insert capabilities. This will allow DS0 circuits to be groomed on selected T1s from each site, without having to supply a DACS at each location.

Designed for harsh environments, the IMUX 2000 T1/E1Multiplexer features Redundant Common Logic Module, built in CSU functionality, DS0 squelching capability and Fast Reframing Channel. The unit provides full featured, Drop-and-Insert capability for each voice frequency circuit or any signal that can be transmitted in a DS0 channel. Channel cards are available for voice, data, telemetry, teleprotection, video and ethernet applications. The IMUX 2000 is both hardware and software configurable. The unit offers the ultimate network management system. It operates in a Windows™ point-and-click environment and provides network visibility from any node which allows for remote provisioning, monitoring and alarm reporting.

To support network management and other IP interfaces that may be required at a site, the cost for a Cisco router/switch is also included at each site.

4.2 Option 4 Design Development

4.2.1 Assumptions

The following assumptions are made for the development of the high-level design for Option 4:

I. TRAFFIC AND PERFORMANCE ASSUMPTIONS

1. Traffic considerations are to primarily support operational requirements only (SCADA)

    a. SCADA-to remain as TDM architecture

    b. Routers will be provided at each site with equipment to allow network management interfaces

    c. Minimum traffic increment is DS0.

2. LAN traffic will be supported by a separate network not part of this option

3. Capacity to be provided to meet current requirements only. However, design should incorporate upgrade paths to increase capacity when it can be cost-effective (i.e. design a microwave path to support OC-3, but only provide equipment for DS-3 as an example.)

4. There should be no decrease in reliability in Option #4, but there may not necessarily be increased reliability if there is a direct cost to do so.

II. CONSIDERATIONS/ASSUMPTIONS TOWERS AND FACILITY

1. Tower work/rehab costs will only be considered at those sites where antenna additions may be required to support space diversity, or a tower height increase is required for clearance.

    a. Each tower that will require additional antennas, antenna replacement, or rehabilitation is assumed to require a structural analysis and cost is provided.

    b. If existing antennas/waveguide appear adequate to support digital upgrade, then additional tower work will not be considered at that site. (example-- keep a wood pole for tower if no space diversity is required and existing antenna is retained)

2. Existing buildings, shelters, power, and chargers are adequate to support an additional rack of equipment during a transition from analog to digital m/w radio. Minimal rehab work required. If a site requires more than one additional rack, there may be a need for building rehab. Otherwise, building and generator replacements will not be included as in the other options.

3. M/w radio system pricing based on Harris prices used for MO radio additions.

III. SPECIAL CONSIDERATIONS-DESIGN

Radio

1. Baseline capacity considerations: a minimum of DS-3 radios on designated backbone paths, low capacity radios on single thread and secondary branches.

    a. All sites equipped with at least one RFL IMUX T1 bank. Additional RFL channel banks are provided at sites that appear to require more than 24 channels dropped.

    b. For budgeting purposes, use of licensed 6 GHz frequency band is incorporated in the high-level design for all rings and paths that assume a licensed radio, however it is acknowledged that some shorter paths may utilize higher frequencies. All are subject to availability through frequency coordination.

3. Existing antennas and waveguide may be reused, however a certain percentage of sites are assumed to not pass a waveguide sweep performance test and would need to be replaced.

4. Existing paths and antenna/tower heights assumed to be adequate to support a new digital radio path, except where noted. Space diversity antennas added below existing antennas, to keep from adding tower heights, and extra expense. This should be reviewed further on path by path basis in detailed design.

5. Pricing of all radios includes a hot standby configuration.

TDM Paths via Sycamore DACS (Timeplex replacement)

1. Equipment used is Sycamore DNX-11 or 1u and RFL IMUX multiplexer.

2. DNX-11 DACS sites will have timing and synchronization equipment.

3. For network T1's terminating on a DNX, no more than 3 x T1 paths to neighboring nodes (one path can have multiple T1s, however).

4. Currently leased T1's are part of the existing baseline $2.2 million OPEX costs to Ameren. Any changes from the current configurations will be shown as deltas from the $2.2 million baseline amount.

5. LAN traffic currently on Timeplex network is assumed to migrate to a separate network.

6. Any existing leased DS-3 circuit can be used to transport operational or WAN traffic, however a review will be necessary to determine spare capacity that is actually available on DS-3s.

While assessing the equipment direct replacement requirements, several “opportunities” are noted that are included in the overall design. These appear to provide additional value at a small incremental cost. These are discussed in the following sections.

4.2.2 Consideration of Fiber or Radio from Moweaqua to Route 51 substation

Under the present architecture, the analog radio network is disconnected directly from the primary circuit destination. In the past, circuits were directed to Mattoon, Effingham, or other sites located on the analog microwave rings that were associated with particular individual company control centers. Now, as the Ameren consolidated company requirements evolve over time, the primary destination of most of the circuits is to the Decatur area. Under the existing architecture, the only way for a circuit to exit the digital microwave system is through the leased DS-3 lines at Pawnee, Mattoon, or Springfield, routing either via St. Louis GOB or only direct from Springfield. It is anticipated that with this arrangement at some point in the future, the need for additional leased DS-3’s may be required to support the concentrated operational traffic that is also shared with WAN and voice traffic. Additional leased DS-3 would add to recurring OPEX costs, making additional expense for Ameren.

A private alternative path can be easily established from the digitial radio network to the Decatur fiber ring simply by extending a path from Moweaqua microwave site to Route 51 substation, which is located on the Decatur fiber ring. The straight line distance is approximately 11 miles to make this connection. For a relatively small incremental cost, system reliability can be increased cost-effectively. Therefore it is recommended that this connection be established.

The Moweaqua-Route 51 substation route has been included in the Option 4 costs as a fiber route, which is estimated to be in the same price range as establishing a microwave path. Fiber would be the preferred connection, since it offers additional security, capacity, and easier implementation, and the need for frequency coordination and tower work is eliminated. However, right of way availability will need to be verified. The path design and choice should be confirmed during the detailed design activity.

4.2.3 Leased T1s from New DNX Nodes

The advantage of establishing a digital microwave network is that each microwave site can become a point of access to transport circuits across a private network. Economies can be

gained by redirecting existing leased lines from Timeplex nodes that go across multiple LATAs, to a closer interface point on the microwave network that is in the same LATA when possible. Generally, leased intra-LATA T1s are more economical that the inter-LATA T1s since they may originate and terminate within the same telco serving area without getting multiple carriers involved.

A review of potential T1 connectivity for operational traffic does show that economies can be gained by eliminating some existing T1s, retaining some existing T1s, and adding some T1s to microwave radio interface points for private transport to the final destination.

T1 connectivity was developed using the criteria that no more than three leased network T1 paths should connect to any DNX network node. This ensures that a level of alternate routing and availability exists, comparable to what is provided today.

Figure 4-1 graphically shows the new T1 lines for the operational network in relation to their connectivity to the digital microwave network. The numbers in black at each DNX location indicate the quantity of DS0s that are required to be dropped at the location. “XX” over a line denotes a leased T1 route that would be discontinued. Numbers in blue, along with the solid line boundaries indicate the associated LATA. T1 connectivity has been developed to allow alternative paths for the DS0’s in the event of loss of one T1 link between two sites.

A consideration also taken into account is the need to separate the Corporate WAN (non-operational) traffic from the operational traffic. This is beneficial from a NERC compliance standpoint. The cost impact of this segmentation is discussed in the following section.

4.2.3.1 Cost Analysis of Operational Leased T1 Network

Table 4-2 shows T1 circuits that would be deleted, added and retained in the scenario to redirect leased T1 circuits to optimize DNX connectivity, and the present monthly costs. The current cost of the “combined operational/WAN T1 network is $35,774 monthly, or $429,288 yearly (sum of deleted + retained T1 lines in Table 4-2**;** previously shown in Table 3-1). By redirecting T1s to selected microwave sites or even to St. Louis when it is in the same LATA as a site, a net decrease of $12,414 monthly ($148,968 yearly) recurring OPEX to support operational requirements is realized. ($23,614 T1s eliminated with $11,200 added back to establish new intra-LATA T1s).

The results in a yearly cost for operational T1 circuits of **$280,320**.

Figure 4-1: Map of New Leased T1 Connectivity

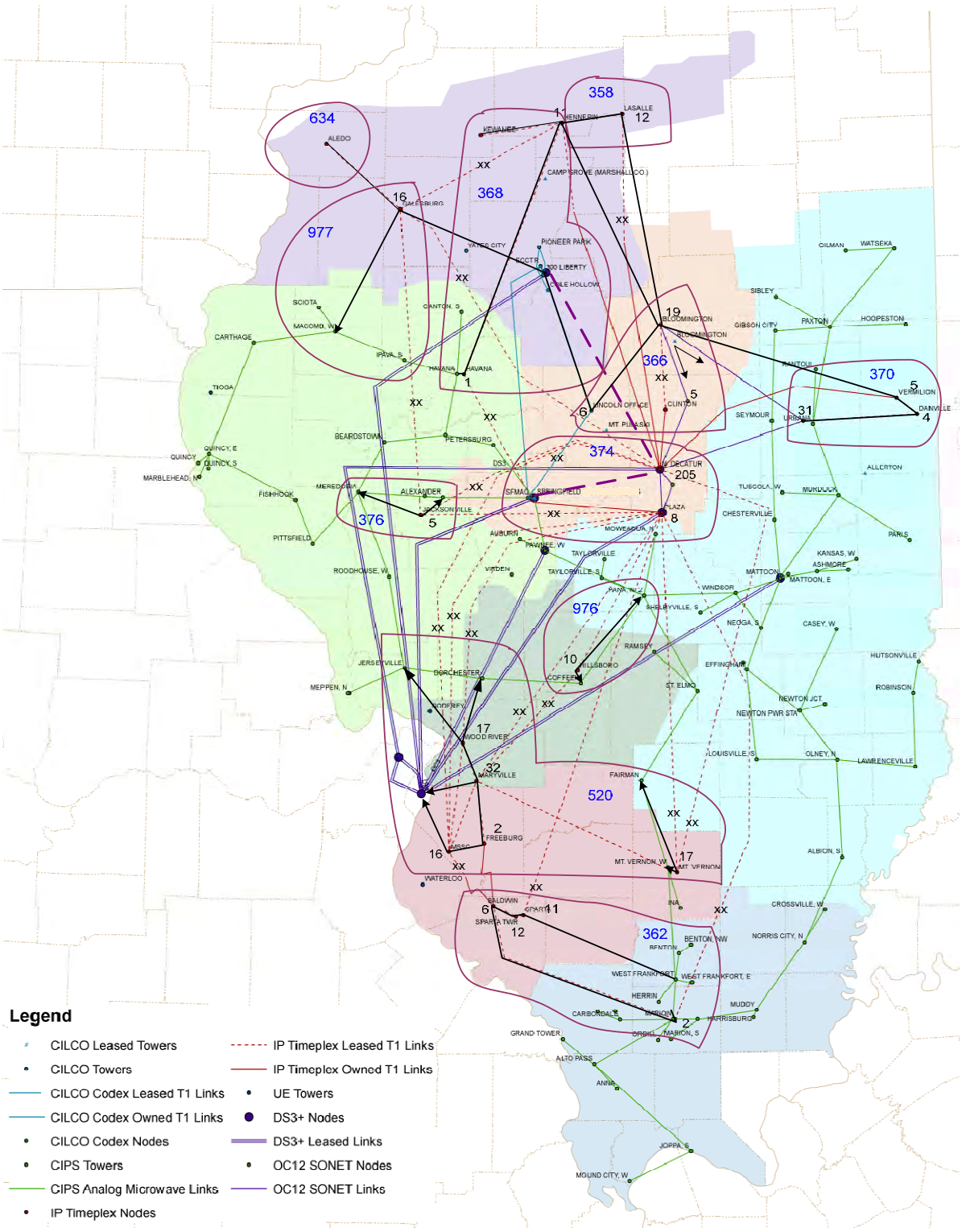


Table 4-2: Operational T1 Reallocation

Site A	Type	Site B	Type	Notes	Action	No. of T1s	Amount Monthly
Galesburg ofc		*Hennepin PS*			*delete*		991.23
Galesburg ofc		*Decatur Plaza*			*delete*		1,019.60
Galesburg ofc		*Jacksonville ofc*			*delete*		998.14
LaSalle ofc		*Champaign ofc*		*To N. Decatur via fiber*	*delete*		885.21
Jacksonville ofc		*N. Decatur*			*delete*		680.80
Jacksonville ofc		*Decatur Plaza*			*delete*		891.22
Bloomington ofc		*Clinton PS*		reroute via fiber	*delete*		481.94
Belleville ofc		*N. Decatur*			*delete*		885.21
Belleville ofc		*Decatur Plaza*			*delete*		819.26
Belleville ofc		*Wood River PS*			*delete*		320.00
Belleville ofc		*Maryville ofc*			*delete*		1,064.00
Belleville ofc		*Baldwin PS*			*delete*		896.00
Maryville ofc		*Mt. Vernon ofc*			*delete*		3,148.00
Maryville ofc		*Decatur Plaza*			*delete*		909.21
Maryville ofc		*Hillsboro ofc*			*delete*		1,467.46
Wood River PS		*N. Decatur*			*delete*		905.21
Sparta ofc		*N. Decatur*			*delete*		640.34
Mt. Vernon ofc		*Decatur Plaza*			*delete*		1,400.84
Mt. Vernon ofc		*N. Decatur*			*delete*		900.21
Marion SIPC		*Decatur Plaza*			*delete*		905.21
Hillsboro ofc		*Decatur Plaza*			*delete*		620.00
Havana PS		*Decatur Plaza*			*delete*		885.22
St. Louis GOB		*Wood River PS*			*delete*		358.39
St. Louis GOB		*Wood River PS*			*delete*		250.06
St. Louis GOB		*N. Decatur*		use existing DS-3 &OC-3	*delete*		813.02
Lincoln ofc		*Springfield MAC*		*CODEX T1*	*delete*		478.63
					TOTAL REMOVED		**23,614.41**
Lincoln ofc	office	Bloomington	office	new replacement T1 (CODEX)	NEW	1	1,000.00
Galesburg ofc	office	Macomb W	138 kv sub	**Positron reqd at Macomb W**	NEW	1	800.00
Galesburg ofc	office	Peoria Liberty	office		NEW	1	800.00
LaSalle ofc	office	Bloomington	office	via fiber to N. Decatur	NEW	1	1,200.00
Jacksonville ofc	office	Alexander	m/w repeater		NEW	1	500.00
Jacksonville ofc	office	Meredosia	138 kv sub	**Positron reqd at Meredosia**	NEW	1	500.00
Hillsboro ofc	office	Pana #1	345 sub	**Positron reqd at Pana #1**	NEW	1	700.00
Hillsboro ofc	office	Coffeen m/w	m/w site		NEW	1	700.00
Belleville ofc	office	Freeburg Gas Field	gas ofc		NEW	1	1,000.00
Belleville ofc	office	St. Louis GOB	office		NEW	1	500.00
Maryville ofc	office	St. Louis GOB	office		NEW	1	500.00
Wood River PS	Power station	Dorchester	m/w repeater	**Positron required at Wood River**	NEW	1	500.00
Wood River PS	Power station	Jerseyville	138 kv sub	**Positron reqd at Jerseyville, Wood River**	NEW	1	500.00
Marion SIPC	office	Marion	161 kv sub		NEW	1	400.00
Sparta ofc	office	W. Frankfort	230 kv sub	**Positron reqd W. Frankfort**	NEW	1	400.00
Mt. Vernon ofc	office	Mt. Vernon W	345 kv sub	**Positron reqd Mt. Vernon W**	NEW	1	400.00
Mt. Vernon ofc	office	Fairman	m/w repeater		NEW	1	400.00
Havana PS	Power station	Havana m/w	m/w repeater	**Positron Required at Havana PS**	NEW	1	400.00
					TOTAL ADDED		**11,200.00**
Galesburg ofc		Aledo Twr			retain		1,000.46
Hennepin PS		Kewanee Twr			retain		729.51
Hennepin PS		Havana PS			retain		825.75
Hennepin PS		N. Decatur		leased T1 to Bloomington then via fiber	retain		991.23
Hennepin PS		LaSalle ofc			retain		618.00
Bloomington ofc		N. Decatur		on fiber	retain		-
Clinton PS		N. Decatur		on fiber	retain		-
Vermilion PS		Decatur Plaza		leased T1 to Bloomington then via fiber	retain		1,624.64
Vermilion PS		Danville Twr			retain		700.00
Danville Twr		Champaign ofc			retain		700.00
Champaign ofc		Decatur Plaza		via fiber	retain		-
Champaign ofc		N. Decatur		via fiber	retain		-
Maryville ofc		Freeburg Gas Field			retain		800.00
Maryville ofc		Wood River PS			retain		1,500.00
Baldwin PS		Marion SIPC			retain		705.50
Baldwin PS		Sparta Twr			retain		846.97
Sparta Twr		Sparta ofc			retain		414.50
Baldwin PS		Freeburg Gas Field		private microwave path	retain		-
Lincoln ofc		Peoria Liberty		CODEX path	retain		704.04
					TOTAL RETAINED		**12,160.60**

4.2.3.2 Cost Analysis of Corporate WAN Leased T1 Network

T1 WAN circuits can also take advantage of the private microwave where it is more cost-effective to terminate a circuit at the nearest intra-LATA microwave site than lease an inter-LATA circuit to N. Decatur.

Table 4-3 shows the sites that will require a T1 WAN circuit to N. Decatur to replace the previous Timeplex circuit, and the corresponding circuit costs from each site. The Table was developed by comparing the costs of direct leased lines and lines terminated at microwave sites. The most economical route was chosen to be included in the WAN connectivity design.

From Table 4-3 below, total WAN costs are $11,500 per month, or **$133,863** yearly.

Table 4-3: T1 Circuits Required for IP Corporate WAN Traffic

Site A	Site B	Notes	No. of T1s	Amount Monthly
Galesburg ofc	Macomb W m/w		1	800.00
LaSalle ofc	Champaign ofc	via fiber to Decatur	1	885.21
Jacksonville ofc	Alexander m/w		1	500.00
Belleville ofc	St. Louis GOB		1	500.00
Maryville ofc	St. Louis GOB		1	500.00
Sparta ofc	West Franfort m/w		1	400.00
Mt. Vernon ofc	Mt. Vernon W m/w		1	400.00
Hillsboro ofc	Decatur Plaza		1	620.00
Shanghai Gas	Macomb W m/w		1	800.00
Hillsboro Gas Field	Coffeen m/w		1	800.00
Hookdale Gas Field	Fairman m/w		1	800.00
Freeburg Gas Field	St. Louis GOB		1	550.00
Tilden Compressor Station	West Franfort m/w		1	550.00
Centralia Gas Field	Fairman m/w		1	800.00
Centralia ofc	Fairman m/w		1	800.00
Mt. Claire ofc	Dorchester m/w	Mt. Claire currently goes to Hillsboro-- cost $636/month. Stay as is if less cost	1	900.00
Marion SIPC	Marion m/w		1	550.00
		TOTAL MONTHLY T1 COSTS FOR WAN		**11,155.21**

(All circuits have a final destination of North Decatur)

4.2.3.3 Total Cost of DNX Leased T1 Network

The total new cost for yearly leased T1 circuits is $280,320 (operational T1)+$133,863 (WAN T1) = **$414,183**. This cost is $15,105 *less* than the original "combined" cost of $429,288.

Therefore, the net effect on the existing $2.2 million budget for recurring OPEX leased line cost is a yearly reduction of $15,105, down to $2.185 mil.

Homing the WAN T1 circuits to microwave sites assume there will be capacity available on the new digital radios.

4.2.3.4 Ground Potential Rise (GPR) Protection Equipment

At substations and generation sites, the local telco typically requires that line protection equipment be installed to protect the circuit against sudden power surges or severe voltage/current fluctuations that could potentially damage the telco equipment and connecting lines. Thus, at each substation that has a leased telco line terminated in it, GPR protection is assumed to be required. However it is also assumed this equipment will be installed and leased from the telco. GPR lease charges are reflected in the monthly recurring costs for a T1 line.

4.2.4 Implementation of OC-3 Radios to Provide Capacity for WAN Traffic

Option 4 focuses on equipment replacement only. With that in mind, the initial goal is to replace the existing 480 channel analog radios with the nearest comparable radio, a 672 channel capacity DS-3 digital radio. The DS-3 radio basically provides enough capacity for operational traffic, with little margin for any type of additional traffic, as well as substantial growth of operational needs.

As discussed earlier, splitting out the WAN and operational traffic on the Timeplex network necessitates additional leased T1s; however OPEX cost economies can be gained by terminating all T1s at a microwave site located within the same LATA, rather than crossing inter-LATA boundaries with leased facilities all the was to Decatur. To support the additional WAN traffic over the private microwave network would necessitate the provision of additional capacity on the microwave network. To support this requirement, OC-3 radios could be implemented for an incremental CAPEX cost.

In general, radios that support up to OC-3 capacities will require more stringent RF engineering design in terms of path performance and reliability. Path fade margins, and interference reduction will need to be improved through the use of high gain antennas, and in some cases, higher power transmitters on some longer paths. The use of space diversity will be required on most of these longer (>20 miles) high capacity paths as well. These factors contribute to the additional costs of providing OC-3 radios, however much of this is also required for DS-3 radios.

Additional space diversity antennas must also be accommodated by existing towers, which may require a level of tower rehabilitation.

Attachment 4 shows the results of an analysis performed to compare the tower, facility and path requirements between the DS-3 and OC-3 radio. The analysis took into account the following factors:

- Possible need to add tower height for terrain clearance—this requirement is common for both DS-3 and OC-3 radio paths.
- A review of path availability with and without space diversity. If a path availability of 99.999% or better could not be achieved with a single dish, a space diversity dish was added
- Requirements for high power and larger antennas to support a 35 dB fade margin to ensure reliable.

The above factors were translated into additional radio and tower requirements to support them. Results of the cost analysis indicate that provisioning for OC-3 radios adds $3.4 million over the cost of the cost of provisioning for DS-3 radios. The cost analysis summary is shown in Figure 4-2.

Figure 4-2: OC-3 Radio Incremental Cost Summary

	Item	no. of paths	incremental cost per path	Total	Notes
1	Incremental cost of OC-3 radio (both ends)	60	$23,750	$1,425,000	includes installation & misc
2	High power upgrade (+29 to 32 dBm)(both ends)	38	$9,235	$350,930	includes installation & misc
3	6' space diversity antenna & w/g (both ends)	18	$24,000	$432,000	includes installation & w/g
4	Increase primary antenna size from 8' to 10' (both ends)	5	$5,000	$25,000	includes incremental installation
5	Increase primary antenna size from 6' to 8' (both ends)	9	$3,400	$30,600	includes incremental installation
6	Increase diversity antenna size from 6' to 8' (both ends)	5	$3,400	$17,000	includes incremental installation
			TOTAL: RADIO AND ANTENNA EQUIPMENT	**$2,280,530**	
		Sites	**cost per site**	**Total**	
7	Tower analysis for diversity or dish size increase	20	$8,000	$160,000	
8	assumed tower rehab for diversity or increased antenna	20	$25,000	$500,000	
			TOTAL	$660,000	
9	Add 25% contingency for tower and facility work			$165,000	
			TOTAL radio, antenna, and tower	**$3,105,530**	
			10% contingency	$310,553	
			GRAND TOTAL	**$3,416,083**	

Implementing the OC-3 radios initially during the planned major communications transport upgrade would be significantly more cost effective than having to go back a few years later and retrofitting DS-3 radios and upgrading paths. Therefore, it is recommended OC-3 radios be

implemented initially to support additional T1's for WAN traffic. Budgetary estimates have been developed with OC-3 radios. The budget as developed can be reduced by **$3.4 million** if reversion to DS-3 radios is required.

Provision of OC-3 radios provides increased flexibility to support future connectivity requirements such as smart grid, 345 kv substations, and generating facilities.

4.2.4.1 Additional Opportunity to Utilize OC-3 Radios and Reduce OPEX for T1 WAN Traffic

Attachment 5 contains a list of 89 microwave sites, and the proximity of office locations to those sites. Twenty out of 89 sites (22.5%) have collocated offices, with another 11 sites (12%) located 1 to 1½ miles away. Most of the office locations currently have WAN connections through some form of inter-LATA leased facility. At the offices collocated with a microwave site, a short run of fiber or copper would only be required to access the microwave site. Offices within a few thousand feet of a microwave site could eventually be connected via unlicensed radio at an economical cost. Each instance is a potential trade of OPEX leased lines costs for CAPEX dollars, and should be reviewed further for feasibility.

4.2.5 Establishment of OC3 Radio Path From Liberty to Brokaw

Ameren is currently working with Excelon on interconnecting paths to support operations (relay protection and SCADA). As part of this effort, Excelon is planning to establish and build a radio site at Mackinaw, IL in 2009. An opportunity exists for Ameren to build a microwave route using the Mackinaw site as a repeater point that could provide connectivity in the Peoria/Bloomington area, as well as enhance communications facilities between Ameren and Excelon in the future.

An OC-3 microwave route could be built between Peoria-Tazewell-Mackinaw-Brokaw. The Brokaw site has access to the Bloomington/Champaign/Decatur fiber ring which could be utilized to transport traffic to Decatur. This has a potential to offer a private facility that could replace the existing leased DS-3 that currently exists between Peoria and North Decatur.

This opportunity is most effectively available now in 2009 while the Mackinaw site is still in the planning and implementation stages. Therefore, an **$855,000** estimated cost for this route has been included in the Option 4 phase 1 budget estimate. This amount can be subtracted from the budget if it is not implemented.

5. Implementation Phasing and Cost

5.1 Methodology Used in Developing Phases and Costs

To develop costing and high level equipment requirements, a template spreadsheet was developed and applied to each site, following the methodology performed for the previous alternatives. The template contains various types of equipment and facility options including radio and antennas, generators, buildings, fiber, etc.

For each site, an evaluation was made on the type of equipment that would be required for basic equipment replacement (consistent with the primary goal of Option 4). However it should be noted that in the case of replacing analog radios with digital, additional work was identified to add antennas, and tower work to support digital radio operation. Typically, a digital signal is not as “forgiving” as analog on longer radio paths, and additional measures have to be taken to ensure digital performance will be in acceptable limits. Thus even though the focus is on direct equipment replacement, there is required additional tower and antenna work in approximately a third of the microwave paths included in Option 4.

Each site spreadsheet that was developed was associated with initial ring configurations followed in the previous three alternatives. Summary sheets were developed for each group of sites, which were hierarchically rolled up into a master summary sheet depicting total alternative costs.

Since the existing architecture is maintained for Option 4, the ring topology developed in the previous 3 alternatives was abandoned for the actual topology consisting of the 3 major analog baseband rings, and separate sites connected via leased T1 facilities. The existing architecture was developed into phases and costed.

5.2 Phases

Carrying over from the previous alternatives, the goal of the network replacement is to retire the legacy analog radio, Timeplex, CODEX, and NORTEL networks before they become service affecting and cause a degradation of service. The network implementation should not be scheduled too short where time frames cannot realistically be met, or too long where the total overall in-service exceeds a reasonable planning horizon, and places a greater risk of failure of the existing networks before then replacement can be installed. The implementation time frame has to also be sensitive to the budgetary requirements and constraints for any given year. Option 4 has been developed based on a 5-year implementation, to spread total budget as feasibly possible.

The phases have been developed based on existing architecture. For the implementation period, existing analog radios must co-exist with new digital radios, until phase 5 when all radios are finally migrated. The goal of the implementation should be to minimize the amount of digital-to-analog (D/A), and analog-to-digital (A/D) conversions between the systems which can add additional cost for the converters, and would only be used temporarily. For any A/D conversions that might be necessary, channel banks could be used to interface voice grade circuits at the DS-0 level, however, there may still be costs for voice channel cards that have no reuse anywhere later. To minimize A/D conversion requirements entire baseband rings should be migrated as one phase. By taking this approach conversions may only be necessary at the key interface points between the rings: Pana (West and main ring) and Mattoon (main and North ring). Rolling to the Main baseband ring from the West ring as the next phase eliminates the Pana interface by the next phase, leaving only Mattoon for migration of the North ring in Phase 4.

Many of the single thread microwave links currently interface to the analog backbone via audio patches to connect some of the narrow-band paths to the main line. The remainder of the narrow-band paths are connected to the main backbone using MC400 channel translators. The translator cage connects to the narrow-band radio and to the wide-band baseband combiner as a coaxial baseband signal, and thus would have a cost involved to insert any type of A/D conversion facility. Where audio patches are used, the facilities for an A/D conversion are already in place. The Attachment 3 map shows the microwave paths that connect via translators or audio patch. To level the implementation resource requirements and budget, the paths with audio patches have been deferred to phase 5 for replacement, since there is no significant interface cost involved with these paths.

A map showing the Phases of Option 4 is contained in Attachment 6. The five phases of implementation are:

Phase 1: replacement of existing SONET nodes, plus establishment of DNX nodes at selected legacy CODEX and Timeplex sites:

- Lincoln office CODEX
- St. Louis GOB
- Bloomington
- Clinton PS
- N. Decatur
- Decatur
- Champaign

- Vermilion PS

This DNX node group is referred as the “East” DNX nodes.

The Peoria-Tazewell-Mackinaw-Brokaw OC-3 radio route is also included in Phase 1.

Phase 2: Replacement of the analog backbone radio WEST baseband ring, (see Attachment 2 for members), except single thread microwave hops connected to backbone with audio patch. New path from Moweaqua to Route 51 substation also included. Plus, establishment of DNX nodes at selected Timeplex sites:

- Lasalle
- Hennepin PS
- Kewanee (channel bank only)
- Galesburg
- Aledo (channel bank only)
- Havana PS
- Jacksonville
- Hillsboro

This DNX group is referred as the “North” DNX nodes.

Phase 3: Replacement of the analog backbone radio MAIN baseband ring (see Attachment 2 for members), except single thread microwave hops connected to backbone with audio patch.

Phase 4: Replacement of the analog backbone radio NORTH baseband ring (see Attachment 2 for members), except single thread microwave hops connected to backbone with audio patch. Plus, establishment of DNX nodes at selected Timeplex sites:

- Wood River PS
- Maryville
- Freeburg Gas Field
- Belleville office
- Baldwin PS
- Sparta Tower
- Sparta office
- Marion SIPC
- Mt. Vernon office

This DNX group is referred as the “South” DNX nodes.

Phase 5: replacement of single thread microwave hops that currently connect to backbone with an audio patch. These paths include:

- Ashmore
- Baldwin microwave (not connected with audio patch but connecting link to Freeburg Gas Field between two leased T1 DNX networks)
- Canton S
- Charleston
- Freeburg Gas Field microwave (not connected with audio patch but connecting link to Baldwin between two leased T1 DNX networks)
- Ina S
- Jacksonville N
- Kansas W
- Mattoon E
- Ramsey E
- Sciota
- Sibley
- Tuscola W
- Taylorville
- Taylorville S

The order of these phases allows a timely and logical transition of circuits from legacy destinations to focusing on N. Decatur. Phase 1 establishes the basic network that surrounds Decatur, so that later phases can be added incrementally; phase 2 starts with the western most network, and rolls toward the east in phases 3 and 4 to ensure that the complete rings can be migrated and interfaced with minimal additional costs for temporary A/D converters. Phase 5 concludes with the single thread microwave paths that already have A/D interface capability that can be delayed in order to level the implementation resource and budget requirements. The microwave ring implementations are timed so sites will be available to terminate leased T1s on the DNX network to minimize additional leased T1 costs.

5.3 Option Four Implementation Costs

5.3.1 Assumptions used in Developing Cost Model

5.3.1.1 Common Cost Component for General Engineering and Project Management

The following sections develop the overall capital CAPEX non-recurring costs, as well as recurring costs including OPEX charges such as Operations and maintenance (O&M) and lease line costs for each alternative.

Added to each alternative is a labor cost to cover general engineering and oversight, project management, and miscellaneous project admin requirements. The cost is based on the following assumptions:

-1 full time Ameren employee for the duration of a 5 year implementation

-1 full time consultant for the duration of a 5 year implementation.

Since this activity is associated with the implementation of a new network, it is considered to be capital cost and added to the CAPEX category for the purposes of the cost/benefit analysis.

5.3.1.2 Baseline Design

Prior to embarking on the project implementation, a detailed design will be performed to develop design criteria as an aid in procurement. For the previous 3 alternatives, this cost was estimated to be $900K. For option 4, this cost is reduced to $735K due to the reduction in the number of sites that are to be included. Discussion on the inclusion of the detailed design cost in the cost/benefit analysis is contained in Section 6.1. Its cost is not included in evaluating the CAPEX cost for Option 4, since it was not included in the previous alternatives and is considered a common cost associated with the RFP process. However, it is included in the 2009 budget estimate for the total project.

5.3.2 Cost Estimate by Phase for Option 4

Attachment 7 contains a zip file with a series of Excel spreadsheet worksheets that are developed for each phase of Option 4, and summed into an overall CAPEX summary sheet. Explanatory notes and assumptions are also included in each site spreadsheet. A summary of all the costs developed for the Option 4 Alternative is shown in Figure 5-1.

Figure 5-1: Summary of Costs for Option 4 Alternative

	RF & MUX	*Antenna System*	*Tower & facility Works*	*SONET & Fiber*	**Total Cost Sites**	**RF Engineering & Freq. Coord.**	**Contingency & Misc**	**Total**
Phase 1: DNX East+SONET	$1,113,368	$51,407	$522,450	$463,644	**$2,150,868**	$27,582	$111,337	*$2,289,787*
Phase 2: West BB Ring+DNX North	$3,475,967	$819,572	$1,886,948	$375,516	**$6,558,002**	$159,572	$347,597	*$7,065,171*
Phase 3: Main BB Ring	$4,616,792	$1,083,370	$3,128,416	$0	**$8,828,578**	$241,094	$461,679	*$9,531,351*
Phase 4: North BB Ring+DNX South	$1,695,210	$202,440	$365,715	$0	**$2,263,365**	$89,740	$169,521	*$2,522,626*
Phase 5: Single Thread m/w	$1,101,977	$56,840	$133,120	$0	**$1,291,937**	$59,180	$110,198	*$1,461,315*
TOTALS	$12,003,314	$2,213,628	$6,036,648	$839,160	**$21,092,750**	**$577,168**	**$1,200,331**	**$22,870,250**
% of total site costs	56.9%	10.5%	28.6%	4.0%			project management and planning	$3,200,000
							TOTAL COST-CAPEX	**$26,070,250**
Recurring O&M Costs (5% of RF & Mux and SONET & Fiber equipment)							Detailed Design	$735,000
TOTAL RECURRING YEARLY O&M	**$642,124**						**TOTAL COST**	**$26,805,250**

5.3.2.1 CAPEX

As shown in Figure 5-1, the overall CAPEX cost of Option 4 (minus the detailed design) is **$26,070,250**. This cost does include the overall engineering and oversight cost of *$3,200,000*.

Phase costs are associated with the complete ring implementations as described earlier.

5.3.2.2 OPEX

Recurring OPEX costs consists of two key components:

- Yearly O&M on the installed capital equipment. For budgetary purposes, O&M is estimated to be 5% of the RF & MUX and SONET & Fiber equipment initial installed cost. From Figure 5-1, this is calculated to be **$642,124**. the O&M cost consists of 2 parts: (1) labor requirements, and (2) spare parts provisioning:

    j) Labor requirements: estimated to be a yearly cost of $3,000 per microwave path x 95 paths = **$285,000**. This equates to 3 to 4 full time equivalents.

    k) Spare Parts: estimated to be **$357,124** (2.8% of RF & mux, fiber & SONET costs)

    This estimate is assumed to remain constant throughout the useful life of the equipment, balanced out by less maintenance requirements in the beginning, and increasing in later years as the equipment ages.

- Recurring monthly lease costs of T1s, T3, and OC-3 circuits. Based on the new T1 connectivity for WAN and operational circuits, the current $2.2 million yearly budget has been reduced to **$2.185 million**, as discussed in Section 4.2.3.

Therefore total recurring yearly costs for Option 4 are the sum of the O&M and recurring leased costs: $642,124 + $2,185,000 = **$2,827,124**. For a comparison with the current system, O&M labor is considered to be a common cost (shown in Figure 5-2) and subtracted out, resulting in a net OPEX for comparison of $2,542,124.

Table 5-1 shows the incremental OPEX cost added per phase until the full OPEX cost is reached by the end of Phase 5.

Table 5-1: Incremental OPEX Cost Addition Per Phase

Site A	Site B	Notes	Phase	No. of T1s	Amount Monthly	Amount Yearly	Cumulative at end of Phase
Lincoln ofc	Bloomington	Operational net	1	1	1,000.00	$12,000	
Bloomington ofc	N. Decatur	Operational net	1	on fiber	-	$0	
Clinton	N. Decatur	Operational net	1	on fiber	-	$0	
Vermilion PS	Decatur Plaza	Operational net	1	1	1,624.64	$19,496	
Vermilion PS	Danville Twr	Operational net	1	1	700.00	$8,400	
Danville Twr	Champaign ofc	Operational net	1	1	700.00	$8,400	
Champaign ofc	Decatur Plaza	Operational net	1	on fiber	-	$0	
Champaign ofc	N. Decatur	Operational net	1	on fiber	-	$0	
Lincoln ofc	Peoria Liberty	Operational net	1	1	704.04	$8,448	
			Phase 1 leased costs in service			$56,744	
			Phase 1 O&M costs in service			$78,850	
					TOTAL PHASE 1	$135,594	$135,594
Galesburg ofc	Macomb W m/w	Corporate WAN	2	1	800.00	$9,600	
LaSalle ofc	Champaign ofc	Corporate WAN	2	1	885.21	$10,623	
Jacksonville ofc	Alexander	Corporate WAN	2	1	500.00	$6,000	
Hillsboro ofc	Decatur Plaza	Corporate WAN	2	1	620.00	$7,440	
Shanghai Gas	Macomb W m/w	Corporate WAN	2	1	800.00	$9,600	
Hillsboro Gas Field	Coffeen m/w	Corporate WAN	2	1	800.00	$9,600	
Mt. Claire	Dorchester m/w	Corporate WAN	2	1	900.00	$10,800	
Galesburg ofc	Macomb W	Operational net	2	1	800.00	$9,600	
Galesburg ofc	Peoria Liberty	Operational net	2	1	800.00	$9,600	
LaSalle ofc	Bloomington	Operational net	2	1	1,200.00	$14,400	
Jacksonville ofc	Alexander	Operational net	2	1	500.00	$6,000	
Jacksonville ofc	Meredosia	Operational net	2	1	500.00	$6,000	
Hillsboro ofc	Pana #1	Operational net	2	1	700.00	$8,400	
Hillsboro ofc	Coffeen m/w	Operational net	2	1	700.00	$8,400	
Havana PS	Havana m/w	Operational net	2	1	400.00	$4,800	
Galesburg ofc	Aledo Twr	Operational net	2	1	1,000.46	$12,006	
Hennepin PS	Kewanee Twr	Operational net	2	1	729.51	$8,754	
Hennepin PS	Havana PS	Operational net	2	1	825.75	$9,909	
Hennepin PS	N. Decatur	Operational net	2	1	991.23	$11,895	
Hennepin PS	LaSalle ofc	Operational net	2	1	618.00	$7,416	
			Phase 2 leased costs in service			$180,842	
			Phase 2 O&M costs in service			$192,574	
					TOTAL PHASE 2	$373,416	$509,010
			Phase 3 leased costs in service			$0	
			Phase 3 O&M costs in service			$230,840	
					TOTAL PHASE 3	$230,840	$739,850
Belleville ofc	St. Louis GOB	Corporate WAN	4	1	500.00	$6,000	
Maryville ofc	St. Louis GOB	Corporate WAN	4	1	500.00	$6,000	
Sparta ofc	West Franfort m/w	Corporate WAN	4	1	400.00	$4,800	
Mt. Vernon ofc	Mt. Vernon W m/w	Corporate WAN	4	1	400.00	$4,800	
Hookdale Gas Field	Fairman m/w	Corporate WAN	4	1	800.00	$9,600	
Freeburg Gas Field	St. Louis GOB	Corporate WAN	4	1	550.00	$6,600	
Tilden Compressor Station	West Franfort m/w	Corporate WAN	4	1	550.00	$6,600	
Centralia Gas Field	Fairman m/w	Corporate WAN	4	1	800.00	$9,600	
Centralia Office	Fairman m/w	Corporate WAN	4	1	800.00	$9,600	
Marion SIPC	Marion m/w	Corporate WAN	4	1	550.00	$6,600	
Belleville ofc	Freeburg Gas Field	Operational net	4	1	1,000.00	$12,000	
Belleville ofc	St. Louis GOB	Operational net	4	1	500.00	$6,000	
Maryville ofc	St. Louis GOB	Operational net	4	1	500.00	$6,000	
Wood River PS	Dorchester	Operational net	4	1	500.00	$6,000	
Wood River PS	Jerseyville	Operational net	4	1	500.00	$6,000	
Marion SIPC	Marion m/w	Operational net	4	1	400.00	$4,800	
Sparta ofc	W. Frankfort	Operational net	4	1	400.00	$4,800	
Mt. Vernon ofc	Mt. Vernon W	Operational net	4	1	400.00	$4,800	
Mt. Vernon ofc	Fairman	Operational net	4	1	400.00	$4,800	
Maryville ofc	Freeburg Gas Field	Operational net	4	1	800.00	$9,600	
Maryville ofc	Wood River PS	Operational net	4	1	1,500.00	$18,000	
Baldwin PS	Marion SIPC	Operational net	4	1	705.50	$8,466	
Baldwin PS	Sparta Twr	Operational net	4	1	846.97	$10,164	
Sparta Twr	Sparta ofc	Operational net	4	1	414.50	$4,974	
Baldwin PS	Freeburg Gas Field	Operational net	4	on radio	-	$0	
			Phase 4 leased costs in service			$176,604	
			Phase 4 O&M costs in service			$84,761	
					TOTAL PHASE 4	$261,365	$1,001,215
			Phase 5 leased costs in service			$0	
			Phase 5 O&M costs in service			$55,099	
					TOTAL PHASE 5	$55,099	$1,056,314
		leased=	$414,190	O&M=	642,124.00		
					GRAND TOTAL YEARLY RECURRING ASSOCIATED WITH OPTION 4 IMPLEMENTATION	***$1,056,314***	
					Add back remainder of leased costs for other Ameren circuits that remain the same during implementation	$1,770,817	
					TOTAL YEARLY RECURRING	**$2,827,131**	

5.4 Comparison of Option 4 With Other Alternative Attributes and Costs

Figure 5-2 shows a dashboard summary of the key attributes and costs of each alternative, compared with the current transport system. Section 5.4.1 summarizes Option 4 considerations in relation to the current system and previous three alternatives.

Key future requirements include the considerations for SmartGrid services, as well as providing a system that can meet current and future NERC requirements for reliability and security. Clearly, the current system was designed and implemented long before these requirements were developed, thus cannot efficiently meet these requirements with the current legacy and obsolete platform. However the evolution of NERC in recent years has necessitated some action on the current network to be compliant, therefore it is recognized that it can meet NERC requirements to some extent. As discussed in the previous Report, the current network, while not fully meeting network reachability and performance objectives, is not blatantly under performing to the point of major service disruption; however it is at risk for a major service disruption due to its age and supportability. The current network is just not positioned and flexible enough to meet the challenges of future requirements for a more ubiquitous and converged platform, hindered by obsolete technology.

Among the four alternatives, the Total Owned solution provides the most benefit to meet the key attributes, but at a price. It is considered to be the most secure and reliable since the architecture does not depend on third party carriers to transport Ameren traffic; the network is totally under Ameren control from end-to-end.

However, on the other hand, the Total Owned solution will have a more complex implementation, requiring resources to manage, coordinate frequencies and develop detailed designs, installations, and acceptance testing. Since the other three alternatives offload some of that work to the carrier, their ease of implementation is rated somewhat better than the Total Owned alternative. The four alternatives are also rated equivalent for overall flexibility to meet changing requirements, for the same reason of being able to coordinate changes with a carrier rather than having to be responsible for redesign of a private network to accommodate changes.

Finally, the Hybrid Owned, Total Owned, and Option 4 alternatives are rated better than the Primary Lease alternative in term of simplicity of ongoing operations. These alternatives have more private components under Ameren control that can be managed directly. The Primary Leased alternative depends more on the third party carrier which would require more extensive administration, coordination, and followup in executing day-to-day operations and performance.

Overall, Option 4 appears to optimize a mix of the attributes of the Primary lease, and Hybrid owned solution. It does provide a private ringed backbone network that carries critical circuits and under Ameren control, but utilizes leased circuits to reach outlying sites off the backbone. It does not have dual redundant paths to 345 substations and generation facilities, and does not provide any changes in existing connectivity to several substations, generation, and office facilities. Thus, there are a reduced number of sites included in the Option 4 design. However, Option 4 does provide the opportunity to connect to those sites later, rather than initially, allowing CAPEX costs to be deferred as required to meet budget constraints.

Figure 5-2: Alternative Attribute and Cost Comparison

Key Objectives of Transport Network	Current System	Primary Lease	Hybrid Own	Total Owned	Option 4
System reliability	◑	○	◑	●	○
Mitigation of future facility replacement risks	na	◑	●	●	◑
Capability of meeting NERC requirements	○	○	◑	●	○
Ability to accommodate future smart grid requirements	●	○	◑	●	◑
Provide secure data paths from end-to-end	●	○	○	●	◑
Overall flexibility to accommodate changing requirements	●	◑	◑	◑	◑
Simplicity of ongoing operations	●	○	◑	◑	◑
Ease of Implementation	na	◑	◑	○	◑
Ease of migration toward total owned solution	●	◑	○	●	●
CAPEX	**na**	**$29,347,607**	**$35,650,183**	**$53,004,630**	**$26,070,250**
Yearly Recurring OPEX (NOTE 1)	**$2,200,000 (NOTE 2)**	**$4,201,588 (NOTE 3)**	**$4,027,588 (NOTE 3)**	**$655,643 (NOTE 3)**	**$2,542,124 (NOTE 4)**

Legend
- ● Excellent
- ◑ Very good
- ○ Good
- ◑ Fair
- ● Poor

Notes

a) Yearly recurring OPEX includes leased circuit costs + O&M spare parts. For comparison purposes, labor O&M is excluded from all OPEX figures, a common cost based on the assumption that Ameren will utilize existing O&M resources for any alternative.

b) For the current system, yearly spare parts cost is essentially zero, since existing parts inventory is recycled and reused. Therefore, this OPEX cost reflects only leased circuit costs.

c) Yearly recurring OPEX includes leased circuit costs + O&M spare parts.

d) Yearly recurring OPEX includes leased circuit costs that are essentially the current $2.2 million per year + O&M spare parts.

5.4.1 Option 4 Considerations in Comparison with Other Alternatives

- CAPEX costs

  a) Option 4 Includes $1.25 million for enhancement opportunities to (1) add route from Peoria to Bloomington via Excelon's Mackinaw site ($855k), and (2) extending microwave network to Decatur by establishing a path from Moweaqua to Route 51 substation ($395k).

  b) Option 4 CAPEX includes replacement of a third of battery plant associated with new equipment additions at major data aggregation sites that are at the end of or past their useful life. Option 4 *does not* include cost to replace all generators and the two-thirds of battery plant at remaining sites. The other 3 alternatives include costs to replace all generators and battery plant over the course of project implementation.

  c) While the costs of remaining replacement batteries and all generators (total of $5.2 million) are not added to the Option 4 project cost, they are included in the cost/benefit analysis to acknowledge these items must be replaced as a separate project, if not part of this project. The $5.2 million is added after the end of Option 4 phase 5 project implementation, spread over years 6, 7, and 8.

  d) The previous three alternatives budgeted for replacement of buildings that are at the end of their useful life, especially buildings that contain transite material. Option 4 pares down the scope of expenditures for buildings with minimal rehabilitations rather than replacement. (reduction of $1.01 million)

- Attribute Ratings

  e) Option 4 is rated "fair" in the category Mitigation of future facility replacement risks because of the exclusion of replacement battery plants and generators, as explained above.

  f) System reliability: Option 4 has more single thread leased paths to 345kv substations and generation facilities than the other 3 alternatives, just as the current network. The Option 4 private microwave topology has more single points of failure than the other 3 alternatives, similar to the current network. Network reliability of the Corporate WAN T1 circuits are comparable to what is being provided with the current network.

g) NERC Requirements and secure end-to-end paths: The system reliability issues lowers capability to meet NERC requirements compared to other alternatives. However the private microwave backbone is more secure than the leased network in the Primary Leased and Hybrid Owned alternatives, and provides end-to-end security on at least some sites located on the microwave backbone.

h) Simplicity of operations, Ease of implementation, and Ease of migration to Total Owned Solution: The establishment of a private network for the backbone transport provides migration and operation simplicity advantages similar to the Total Owned alternative, and implementation advantages similar to the Primary Lease/Hybrid Owned networks of the convenience of coordinating leased facilities.

i) Ability to accommodate smart grid requirements and Overall flexibility: Implementation of an OC3 backbone provides potential capacity to support requirements, and the widespread locations of microwave sites provide potential access points across the state of Illinois.

5.4.2 Considerations of Tower Work in Option 4 Design

In all alternatives, tower work has been identified associated with the addition of space diversity or new antennas. In the previous 3 alternatives tower work was also associated with increasing tower height to accommodate new paths, or establishing new towers at sites for new paths. A certain amount of work was also assumed to rehab towers based on a cursory review of inspection reports, and making high-level assessments on whether a tower may need general upgrading based on its age or apparent condition.

In Option 4, since the focus is mainly on equipment replacement, less emphasis was placed on general rehab of towers based on apparent age or condition unless it had the potential to directly affect the capability to add space diversity or replacement antenna loading. Option 4 does not add any new radio routes (other than the Peoria-Tazewell-Mackinaw-Brokaw path in phase 1), so the establishment of new towers for new paths is limited.

However, one aspect taken more into account in Option 4 was an evaluation of existing paths, and their ability to provide adequate clearance with existing tower heights. The previous alternatives assumed existing paths were adequate. The need for an existing path analysis was identified as a result of a review of Alcatel digital path analysis data from 1999, which indicated possible clearance issues on a significant portion of existing microwave paths. While performing the DS-3 vs OC-3 analysis (results contained in Attachment 4), an assessment of clearance was performed on existing paths 20 miles or greater using the criteria of 60’ minimum additional Fresnel zone clearance of the worst case of 1F1 at K=4/3 or .3F1 at K=2/3. (This accounts for trees and buildings that might be in the path.) Attachment 4 shows that many of the existing paths would not meet a 60 foot clearance, based on the referenced clearance criteria. (many paths may meet the 1F1 at K=4/3, but not the .3F1 at K=2/3). However to avoid budgeting for many unnecessary tower height increases without performing a field verification first, a criteria was set that towers on paths not meeting at least a 20’ clearance would be heightened. Complete tower replacements were assumed to be required to accomplish an increase in height. Overall, 12 sites were budgeted for new towers to provide path clearance.

Even though additional towers were budgeted in Option 4 for replacement to meet clearance requirements, this trades off with the additional towers that were budgeted for general rehab in the previous alternatives. Therefore the net cost for tower upgrades on existing routes do not significantly affect the outcome of the option 4 study compared with the previous alternatives, especially since space diversity is generally required on the longer routes in all alternatives.

5.4.2.1 Sites With Legacy Dual Tower

Many of the towers cited for upgrade were dual towers. There currently exists at 11 sites, older dual towers that were built in the 1950's to support old periscope antennas that have long since been removed and replaced with directional parabolic antennas. Most of these dual towers are located on primary longer backbone paths, and will require either rehab or replacement to support space diversity or path clearance.

For reference, these sites and required action are summarized in Table 5-2. These towers have been budgeted for replacement when height increases are needed for path clearance. If only a space diversity antenna is needed, $25K has been budgeted for tower rehab.

Table 5-2: Sites With Existing Dual Tower

Site	SD antenna added for OC3	Height increased for clearance
Alexander	X	X
Alto Pass	X	
Fairman	X	X
GrandTower		
Mattoon	X	X
Meredosia	X	
Mt. Vernon W	X	X
Pana #1	X	X
Pana #2	X	X
St. Elmo	X	X
Windsor	X	

6. Project Implementation Yearly Budget

6.1 Budget for Detailed Design

The Detailed Design for the Illinois Statewide Transport actually consists of two parts: (1) the initial detailed baseline design performed by a Consultant prior to system procurement, and (2) detailed design per phase (performed by vendor), which would be a drill down and confirmation of the baseline design as it applies to the specific phase implementation and vendor solution. Thus costing for the overall detailed design process consists of an initial cost for the baseline design, plus the costs for detailed designs associated with each phase.

In 2009 a detailed design would be established to set a design to be provided to vendors for response to an RFP. Each subsequent phase would include a detailed design associated with each phase, performed by the vendor to confirm the initial detailed design.

For budgetary purposes, the detailed design costs are added to 2009 CAPEX budget to ensure it is captured in Ameren's budget process. For evaluation purposes, it is not included in the NPV analysis, since it is a common cost to all alternatives. However, the detailed design for Option 4 is estimated to be $735,000, which is $165,000 less than the $900K budgeted for the other 3 alternatives. This savings is a result of the reduced number of sites (mainly non-microwave sites, i.e. offices, etc) that are included in the overall Option 4 design. The $165K cost difference in the Option 4 detailed design and the $900K for the other alternatives will be included in the NPV model as a benefit, since a net savings results in Option 4.

6.2 Scheduling of the Phases

Each phase of implementation except the first one is expected to take up to two years, considering the magnitude and complexity of a total network replacement. The first phase consists of a reduced Codex replacement network, SONET nodes, and Timeplex nodes that do not rely on the microwave network, and it is possible that it can be implemented within a single year. The budget for the potential Liberty-Tazewell- Mackinaw (Excelon)-Brokaw route, although part of phase 1, may possibly be implemented in 2010, or traded of with some SONET node implementation if they become a priority and the budget is limited in 2009.

To establish a high-level implementation schedule for planning and budgeting purposes, each phase is considered to have 2 top-level key activities: (1) an engineering period where the network is engineered and equipment procured, and (2) an implementation period, where the equipment is installed, tested, and turned over for service. Each phase can be developed so that the associated network components can be turned up for service once the phase is

completed. Thus, there will not be a need to wait until the end of the 5 year period to consider the network in-service from a benefits standpoint. Each phase will immediately replace legacy equipment and will reduce risk of denial of service due to the misoperation of the old equipment. In addition, as the old analog equipment is replaced, it can be retained as spares for the remaining analog radios until they are completely replaced.

For budgeting purposes, the phase engineering period would occur in the year prior to the bulk of the equipment implementation. The phases are expected to generally spread within a two calendar year period to allow the initial design and then subsequent ordering and installation of equipment and carrier services.

6.3 Yearly Implementation Budget of Option 4

Table 6-1 shows a summary of yearly implementation costs for Option 4 that accounts for engineering and installation periods within each phase, spread over a 2 year period per phase, except for phase 1. Phase 1 does show a portion of installation finishing in the subsequent year. There is a lag of several months between the engineering period and installation period of each phase to allow time for ordering and delivery of equipment, which could take anywhere from 3 to 6 months depending on the type of equipment.

Figure 6-1: High level Implementation Schedule of IL Transport Network

Cost in $000's

CAPEX	2009	2010	2011	2012	2013	
Baseline Design	$735.0					$735
Phase 1	$1,434.8	$855.0				$2,290
Phase 2	$159.6	$6,905.6				$7,065
Phase 3		$241.0	$9,290.3			$9,531
Phase 4			$89.7	$2,432.9		$2,523
Phase 5				$59.2	$1,402.1	$1,461
Program mgmt	$315.8	$1,084.7	$1,271.6	$337.8	$190.1	$3,200
						$26,805
TOTAL	**$2,645.2**	**$9,086.3**	**$10,651.6**	**$2,829.9**	**$1,592.2**	**$26,805**
% of Cost	9.9%	33.9%	39.7%	10.6%	5.9%	100.0%

Cost in $000's

OPEX	2009	2010	2011	2012	2013
incremental	$132.7	$488.4	$696.1	$957.6	$1,008.5
TOTAL	**$2,276.7**	**$2,460.9**	**$2,674.0**	**$2,728.6**	**$2,827.1**

NOTES

1. Each Phase occurs over a 2 year period--design costs for phases 2-5 are shown in the first year, subsequent installation shown in second year. Phase 1 includes design and some procurement in the same year.
2. OPEX will ramp up to the full OPEX yearly cost in 2013.
3. For the most part yearly $2.2 mil OPEX leased line costs are transparent. Existing circuits remain in place until replaced by new routes. Some savings result, accounted in benefits

With the Option 4 implementation plan, all the CODEX, SONET, and East DNX nodes are implemented in the first year, along with the OC-3 microwave path from Liberty-Tazewell-Mackinaw (Excelon)-Brokaw. In years 2 and 3 the largest rings (West and Main) are installed, taking the significant part of the budget (33.9% and 39.7%, respectively), however it may not be cost-effective to split up these ring implementations without incurring additional costs for A/D conversion. In year 4 (2012) the North ring is implemented, however it is much smaller than the West or Main rings. Year 5 (2013) concludes with the few remaining single thread links than can be delayed without additional cost.

6.3.1 Comparison of Option 4 and Hybrid Owned Budgets

Table 6-1 shows the previously recommended Hybrid owned yearly budget compared with the Option 4 yearly budget.

Table 6-1: Comparison of Hybrid Owned and Option 4 Budgets

Year	Hybrid Owned CAPEX	Option 4 CAPEX
2009	$4.3 mil	$1.9 mil
2010	$8.7 mil	$9.1 mil
2011	$8.1 mil	$10.7 mil
2012	$8.0 mil	$2.8 mil
2013	$6.7 mil	$1.6 mil
TOTAL	**$35.8 mil**	**$26.1 mil**

Note: both costs exclude detailed design

The Option 4 budget exceed the original Hybrid Owned budget in years 2010 and 2011, but are greatly reduced in years 2009, 2012 and 2013. The increases in 2010 and 2011 are primarily due to radio replacements occurring within a phase to complete entire rings, which account for a significant portion of the total equipment.

A review of activities in these years may be necessary to realign the budget if CAPEX budget is limited in those years.

7. Option 4 Cost/Benefit Analysis

The basis for the Option 4 analysis is an investment analysis that develops a summary description of the need for investment in the network and a yearly (annualized) estimate of capital investment that is recommended in order to implement/integrate a new network/technology or to migrate the existing network to its target design. Ongoing costs of operations and maintenance (O&M) are identified here. The costs of the Option 4 alternative has been determined using a high-level list of equipment, broad-gauge unit costs, and projected O&M costs so that comparative cost studies and economic justification studies can be carried out.

The investment analysis was performed using Ameren's investment analysis tool, EVA/NPV/ CPWRR model-VERSION 2008-Revision 05-28-2008-NO ENERGY OR CAPACITY PARAMETERS!!

7.1 Assumptions and Parameters Used for the Quantified Cost/Benefit Analysis

7.1.1 Key Parameters Used With the Ameren NPV Model

The following are assumptions made regarding the base parameters for the model. All the default financial parameters (debt and equity ratios, cost of capital, tax rate, etc) were used that are automatically included based on functional category chosen, as explained below. Table 7-1 summarizes the financial parameters that were used in the NPV analysis.

Table 7-1: Financial Parameters Used in the EVA/NPV/ CPWRR Model

	Rates Used in EVA / NPV Analyses		Rates Used in Revenue Requirements Analyses		Rates Used for AFUDC Calculations	
Debt Ratio & Interest Rate:	48.000%	7.250%	48.000%	7.250%	48.000%	7.250%
Equity Ratio & Return on Equity:	52.000%	12.500%	52.000%	12.380%	52.000%	12.380%
Weighted-Average After-Tax Cost of Capital:		8.597%		8.534%		9.918%

Functional category for which the analysis is applicable: the Functional category chosen is "Electric Transmission-Illinois", consistent with the previous three alternatives.

Construction period in years: Each phase of the 5 year construction period can be considered as a stand-alone phase, since each phase can be placed in-service independently. Therefore a construction period is 1 year beginning in 2009, with the first phase in-service in 2010. Subsequent phases go in service for the subsequent years after that.

Base year for present value calculations: the current study year, 2008.

Year that revenue requirements begin to be received: perfect ratemaking is assumed, with revenue realized by the in-service year beginning 2010.

Tax life of capital acquired: The 7-year MACRS tax depreciation model is assumed for all equipment classes (See Section 7.1.2 for a discussion of equipment classes).

7.1.2 Expected Useful Life of Equipment

As indicated in the capital cost summary sheets for Option 4, the capital costs have been categorized into 4 groups of equipment. They have been segmented in order to estimate an expected useful life for the equipment class, used as input in a cost/benefit NPV model. Useful lives of each equipment class has been developed as follows, based on KEMA experience in other utilities and on prudent business practices:

RF and Multiplex: includes radio and multiplex terminals, associated cabling and power and battery supplies. Estimated expected useful life: 20 years

Antenna Systems: Includes antennas, radomes, waveguide, and associated installation. Estimated expected useful life: 20 years

Facility Works: includes microwave towers, buildings and shelters, generators, battery plant, and associated installation. Estimated expected useful life: 40 years

Fiber: includes the installed cost of multi-strand fiber including aerial ADSS, OPGW or buried, and associated optical communications terminals. (Note: the fiber terminals consist of electronic components and could be included in the RF and multiplex category, but for this study has been included with the fiber.) Estimated expected useful life: 30 years.

The Ameren NPV model calculates NPV and economic value over a 50 year period. Therefore an assumption made for the model is that each equipment class will be replaced at the end of its useful life as it occurs over the 50 year interval. No salvage value is assumed, and the replacement costs is the same as the original cost, increased by a 3% yearly escalation factor from the base study year of 2008.

7.1.2.1 Accounting for Existing Facility Works That Are Past Useful Life in Option 4 Cost/Benefit Model

Throughout the Illinois transport locations, a significant portion of buildings, generators, battery plant, and microwave towers are at the end or even past the 40 year facility works estimated

useful life, some even up to 60 years old! The previous three alternatives took into account complete replacement of buildings, generators, and battery plant as part of the upgrade of the Illinois transport network. Microwave towers were budgeted for replacement as required to support additional antennas or provide necessary clearance over certain paths. Replacements as part of the project were assumed to start a new 40 year life cycle.

Option 4 does not automatically replace buildings and generators as part of the life cycle replacements assumed in the previous three alternatives. It does include:

- Replacement of towers as required to support the need for additional antennas or path clearance, similar to the previous three alternatives.
- Replaces battery plant at a third of the sites, those associated with establishment of additional equipment at key data aggregation points.
- Provides minimal rehab of buildings rather than complete replacement.

Because replacement of the old battery and generator facilities is inevitable over the next several years, a separate project will need to be established to address these replacements. To account for these replacements and make an Option 4 comparison more comparable with the other three alternatives, costs for battery and generator replacements have been included after the phase 5 completion of the Option 4 project implementation, in years 6, 7, and 8. Costs included in those years are summarized below:

	Year 6	*Year 7*	*Year 8*	*Total*
Battery Plant	$455K	$455K	$471K	$1,381K
Generators	$1,245K	$1,286.5K	$1,286.5K	$3,818K
TOTAL	**$1,700K**	**$1,741.5K**	**$1,757.5K**	**$5,199K**

Therefore, Option 4 CAPEX cost does not reflect the above lifecycle replacement costs, but the Option 4 cost/benefit analysis does include them.

7.1.3 Phasing in of the Costs

Section 6.3 developed a phased yearly capital budget over a 5 year implementation period. Corresponding OPEX costs were also developed per phase. As each capital phase is placed in service the recurring costs are additive each year so that by the end of implementation year 5,

the full total yearly recurring costs are realized. Recurring costs are assumed to remain constant for the life of the study, escalated by a 3% yearly escalation factor from the base study year of 2008.

7.1.4 Inclusion of Savings From Reduced Leased T1 Expenses

Recurring OPEX expenses were assessed in relation to the current $2.2 million leased line budget. OPEX budget consists of costs for leased lines, plus O&M of the capital equipment. For Option 4, the only variation that exists in the recurring leased costs is the OPEX cost impact of segmenting the WAN and operational traffic to the DNX nodes that replace Timeplex. As discussed earlier, the net impact is a net yearly savings of $15,000. This savings is included as a benefit in the NPV model, to be weighted against the total cost of leased lines plus O&M expenses.

The reduction of the present leased line costs (although small) are also phased in as a benefit as the capital implementation is completed for each phase, so that by the end of implementation year 5 the full total yearly savings from rerouted leased lines are realized. These savings are assumed to remain constant for the life of the study, escalated by a 3% yearly escalation factor from the base study year of 2008.

7.2 Cost/Benefit Results for Option 4

Attachment 8 contains the EVA/NPV/ CPWRR model spreadsheet workbooks associated with the analysis for Option 4. Table 7-2 summarizes the phased CAPEX and OPEX values that were entered into the spreadsheet for analysis.

For cost/benefit evaluation purposes to be comparable to evaluation with other alternatives, cost of O&M labor is added back in to the yearly OPEX costs. Yearly O&M labor was previously subtracted in order to directly compare yearly OPEX based on utilization of existing Ameren resources.

Table 7-2: Option 4 EVA/NPV/ CPWRR Spreadsheet Values

	CAPEX					
	RF & MUX	*Antenna System*	*Tower & facility Works*	*SONET & Fiber*	**OPEX** yearly recurring	**BENEFIT** *(reduced detailed design and T1 costs)*
Year						
2009	$1,362,685			$557,984	$ 2,276,700	$ (165,000)
2010	$4,593,019	$1,049,217	$2,901,988	$452,390	$ 2,460,900	$ (3,000)
2011	$5,648,379	$1,304,382	$3,766,627	$0	$ 2,674,000	$ (9,000)
2012	$2,138,540	$248,314	$448,589	$0	$ 2,728,600	$ (9,000)
2013	$1,363,154	$70,311	$164,670	$0	$ 2,827,124	$ (15,000)
2014			$1,700,000		$ 2,827,124	$ (15,000)
2015			$1,741,500		$ 2,827,124	$ (15,000)
2016			$1,757,500		$ 2,827,124	$ (15,000)
2017 and on					$ 2,827,124	$ (15,000)

7.3 Evaluation of Alternatives

Option 4 is reviewed as a negative NPV project. The project is undertaken as a replacement to develop a critical infrastructure, rather than a business and income producing potential; therefore the goal is to choose an alternative that will meet operating requirements and provide the maximum intangible as well as tangible benefits, while minimizing net cost and providing maximum value to the ratepayers.

Two key evaluation parameters that result from the EVA/NPV/ CPWRR model are:

- Cumulative Present Worth of Revenue Requirements
- Economic Value Added & Net Present Value of Cash Flows

7.3.1 Cumulative Present Worth of Revenue Requirements

The cumulative present worth of revenue requirements provides an indication of the level of cumulative annual revenue that will be required to cover the costs and investment in the project over the study life of the project. The EVA/NPV/ CPWRR model analyzes these parameters over a 50 year period. For this analysis, results for the first 30 years are taken into account.

A key assumption made in this model is that ***PERFECT RATEMAKING IS ASSUMED***! Perfect ratemaking is recouping full revenue to cover all investments and costs by the following year after expenditure. The validity of this assumption is subject to variation by state regulatory authorities!

Figure 7-1 shows the results for Option 4. The key component series of these charts include:

Capital: the cumulative NPV of the annual revenue requirements for capital recovery

O&M: the cumulative NPV of the annual revenue requirements for O&M recovery

Cumulative NPV of Cash Flows: developed from a pro-forma balance sheet of cash flows timed in regard to receipt of revenues and tax effects. If revenue requirements have been developed to match the cash outlay associated with the project, this line should approach zero as the time goes on toward the end of the analysis period.

Offsetting Revenue: this pertains to annual revenue requirements offsets due to post rate case revenues from energy sales in interchange markets and is not applicable to this type of project.

Total: this is the cumulative NPV of the total annual revenue requirement and is the sum of the capital recovery and O&M recovery revenue requirements.

Figure 7-2 shows the Cumulative NPV of total revenue requirements of Option 4 compared with the previous 3 alternatives.

In the Option 4 case, it can be seen that the cumulative NPV of total revenue requirements generally tracks with the other 3 alternatives for the first 5-6 years, then tracks more with the Hybrid Owned alternative during years 7-11. From years 12-30 Option 4 becomes the worst case. By year 30, Total Cumulative revenue requirements are $73 million, which is above the Hybrid-Owned alternative line at $68.7 million shown in Figure 7-2.

In the long term, the Total Owned alternative still represents the best “value” to the ratepayer in that it requires the least amount of revenue over the analysis period, beating the other alternatives by over $20 million.

Figure 7-1: Cumulative Present Worth of Revenue Requirements-Option 4

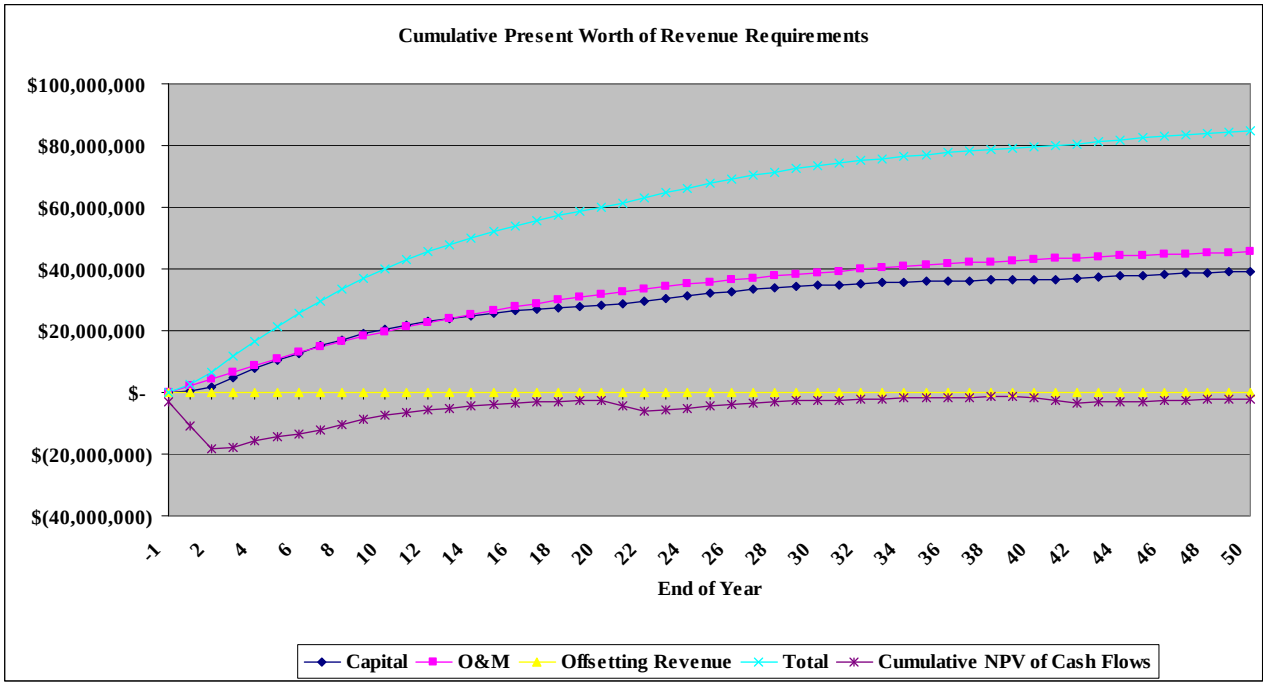
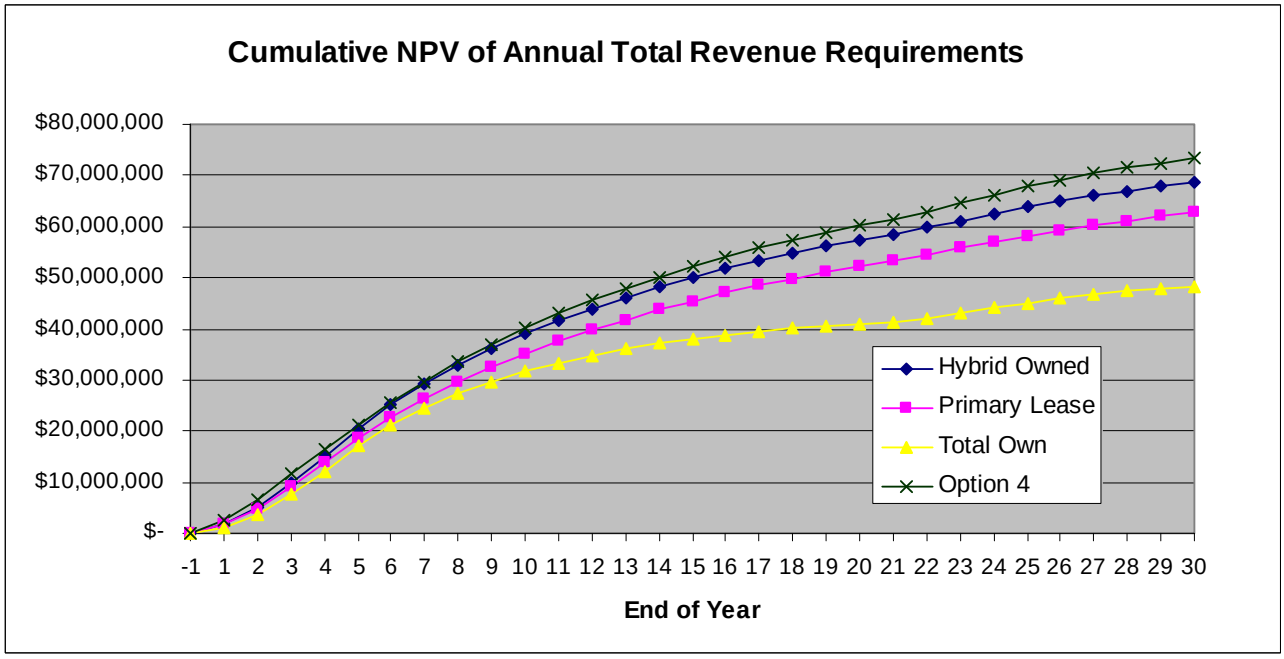


Figure 7-2: Option 4 Cumulative Present Worth of Revenue Requirements Compared With Previous Alternatives



7.3.2 Economic Value Added & Cumulative Net Present Value of Cash Flows

The Ameren EVA/NPV/ CPWRR model calculates 2 parameters that estimate future value and cost to the company in terms of the investment to be made. It calculates the values over a 30 year period.

Cumulative net present value of cash flows: Net Present Value (NPV) includes a time dimension to financial analysis through the use of discounting. As is generally recognized, present values are better than the same value in the future, and earlier returns are better than later ones. Present value tells the worth of future income or expenses today in terms of present dollars, whereas, future value increases due to the compounding effect of interest into progressively larger amounts. The reverse of this, the reduction of future values to lower present value, is what is referred to as discounting. In other words, discounting is the process of finding the present worth of a future value. The interest rate (or cost of capital) assumed for discounting is referred to as the discount rate. Similar to EVA, the model essentially calculates the incremental NPV provided by the project, summarizing a yearly NPV that is the sum of the present and prior years. On any given year in the study period, one can see the NPV that has accumulated up to that point.

Economic Value Added (EVA): in basic terms, it is the monetary value of an entity at the end of a time period minus the monetary value of that same entity at the beginning of that time period. For a company, after-tax earnings minus the opportunity cost of capital. As with any other entity, economic value added essentially measures how much more valuable a company has become during a given time period, due to the implementation of the project under review. The model essentially calculates the incremental EVA provided by the project, summarizing a yearly EVA that is the sum of the present and prior years. On any given year in the study period, one can see the EVA that has accumulated up to that point.

7.3.2.1 Model Results- EVA and NPV of cash Flows for the Three Alternatives

The goal of an alternative is to have a minimally negative EVA and NPV. Figure 7-3 shows the EVA and NPV results of Option 4, and Figure 7-4 and Figure 7-5 show the EVA and NPV of Option 4 compared with the three previous alternatives.

The EVA/NPV/ CPWRR model analyzes these parameters over a 30 year period.

Figure 7-3: EVA and NPV of Option 4

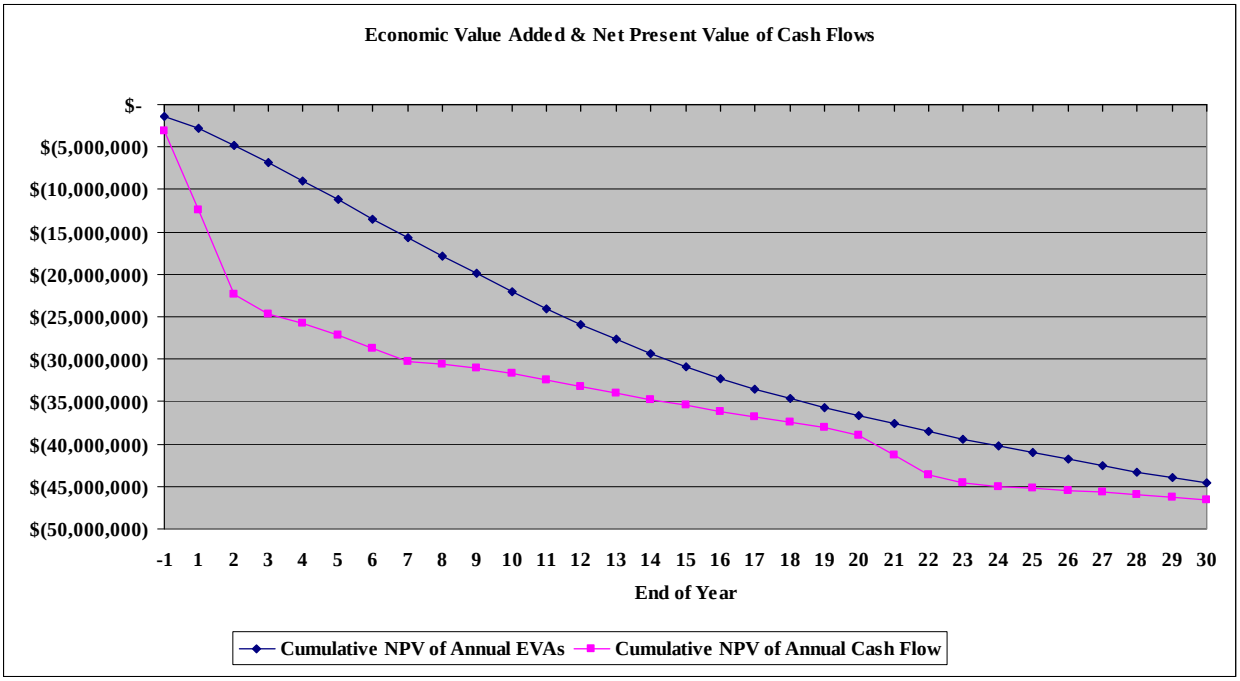


Figure 7-4: NPV of Cash Flow of Option 4 Compared With Previous Three Alternatives

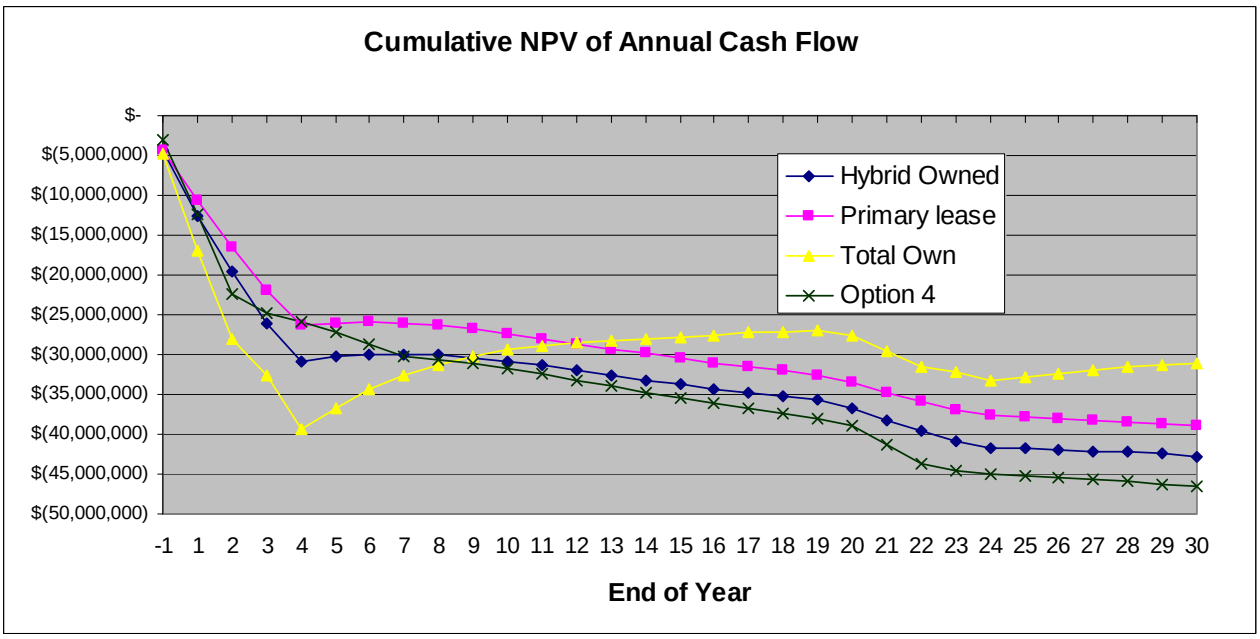
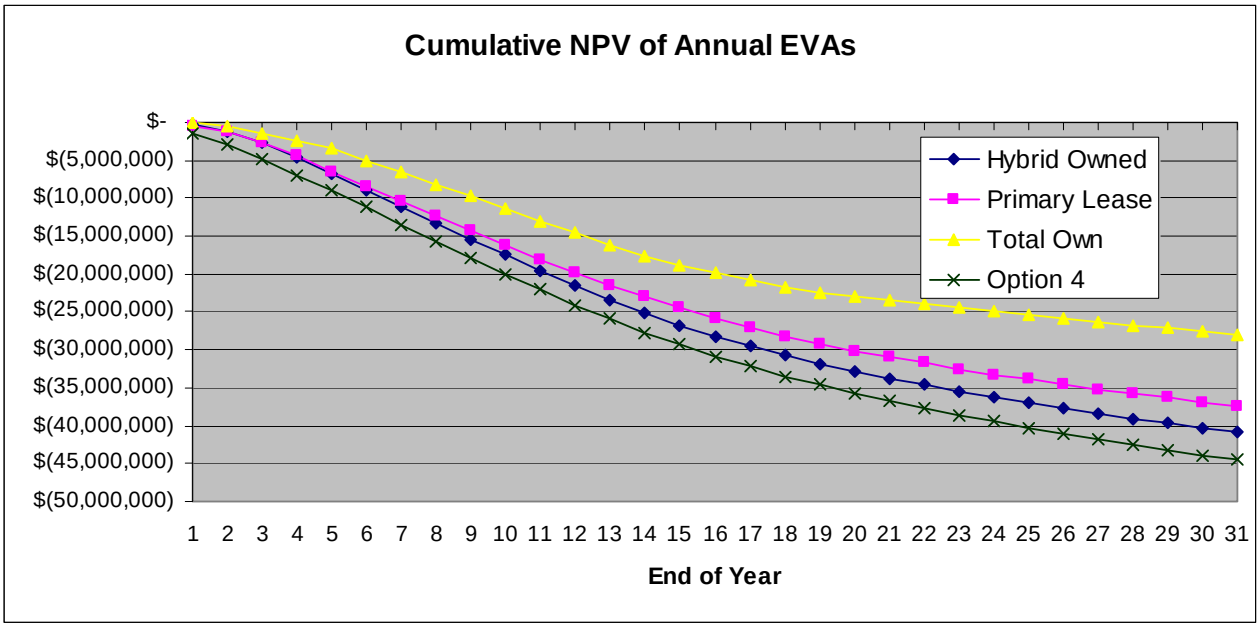


Figure 7-5: EVA Comparison of Option 4 With Previous Three Alternatives



With the NPV cash flow, the Total Owned alternative requires a much greater cash outlay up to year 4 of in-service, but after that begins to gain the returns from revenue and tax benefits, until it comes more cost effective than the other alternatives, as well as Option 4 after 9-12 years. In the near term (less than 6-7 years) Option 4 has a cumulative NPV of cash flow range comparable to the Primary Lease and Hybrid Owned alternatives, but becomes the worst case by year 10, growing to a wider margin by year 30. However, in years 4-5, Option 4 ties the Primary Lease alternative with the least cumulative NPV of annual cash flow.

Over the study period of 30 years for the EVA analysis, the cumulative results continue to be the least negative for the Total Owned alternative. This is aided by the fact that since more capital expenditures are involved that can draw a return on investment, along with recurring expense that are more than a factor of 2 less than the other alternatives, a greater future value is provided to the Company. Similarly, the Total Owned alternative has the least negative cumulative NPV over the total 30 year period. The Primary lease and Hybrid owned alternatives follow similar curves from years 4 to 8 onward, basically spaced by the difference in capital expenditures required. Option 4 is the worst case EVA all the way through the evaluation period.

7.4 Cost/Benefit Evaluation Dashboard

Figure 7-6 presents a summary of the comparisons of the key operational and financial parameters that is used in the final evaluation and recommendation.

Figure 7-6: Cost/Benefit Evaluation Dashboard

KEY DRIVERS	Current	Primary Lease	Hybrid Own	Total Owned	Option 4
NON-FINANCIAL KEY DRIVERS					
Reliability/Operational Risk	●	○	◑	●	◑
Interoperable Platform to Support Future Smartgrid Architecture	●	○	◑	●	◑
Flexibility/Scaleable To Changing Requirements	●	◑	◑	◑	◑
FINANCIAL KEY DRIVERS					
Short-term Cumulative NPV of Revenue Requirements (8 years)	na	◑	⊘	●	○
Long-term Cumulative NPV of Revenue Requirements (30 years)	na	◑	⊘	●	○
Short-term Cumulative NPV of Cashflow (5 years)	na	●	⊘	○	◑
Long-term Cumulative NPV of Cashflow (30 years)	na	◑	⊘	●	○

Legend
- ● Excellent
- ◑ Very good
- ○ Good
- ◑ Fair
- ● Poor

Legend
- ● Best value NPV
- ◑ Better value NPV
- ⊘ Next to least value NPV
- ○ Least value NPV

7.4.1 Non-Financial Key Drivers

The non-financial parameters are pared down to 3 key areas: reliability/operational risk, support of future SmartGrid requirements, and flexibility to changing requirements. Since Ameren sites are subject to changing requirements in Illinois as the new consolidated organization is sorted out, flexibility to accommodate changing requirements is considered an important attribute to the new statewide transport network.

As discussed previously, the Total Owned alternative provides the best reliability and lowest operational risk since there is no involvement of outside third party carriers, and the network is in full control by Ameren. The Hybrid Owned is a bit better than the Primary Lease alternative, since it has more private facilities, but still depends on the carrier for the transport backbone. Option 4 actually provides a better mix of facilities between the Primary lease and Hybrid owned alternatives in that it makes primary backhaul facilities a private network that would be under Ameren control. However, there is a higher reliance on leased single paths to remote sites, utilizing local loop facilities and decreasing reliability on a link. This has been mitigated somewhat by planning for shorter intra-LATA T1 lines terminating on microwave sites to provide access to the private backhaul. This assumes OC-3 radios are implemented to accommodate the WAN requirements. The existing Ameren microwave backhaul does consist of 3 distinct rings that can provide a level of redundancy and protection with the proper switching implementation.

All alternatives are rated equally for flexibility to changing requirements, as the private network trades off with the leased infrastructure in regards to control and provision of private facilities versus just placing an order for new or reconfigured facilities.

7.4.2 Financial Key Drivers

There are 2 key financial parameters of importance to Ameren— the overall value to the ratepayers and the overall net cash flow impact, as discussed in the previous section.

7.4.2.1 Cumulative NPV of Revenue Requirements

A comparison of cumulative NPVs of rate requirements is performed at certain milestones over the study life. For evaluation, representative near-term and long-term numbers are reviewed at 8 and 30 years, respectively, from beginning of project in-service:

	Year 8 Cumulative NPV of Revenue Req.	Year 30 Cumulative NPV of Revenue Req
Totally Owned	$27,300,738	$48,246,374
Primary Lease	$29,566,345	$62,673,947
Hybrid Owned	$32,826,455	$68,683,015
Option 4	$33,609,197	$73,397,349

The year increments are chosen to examine how the rate requirements may change over the life of the project. Year 8 is chosen because it is at this point the values for each alternative begin to graphically diverge from each other. At both milestones, the Total Owned alternative shows the best value, the Primary Lease the next best value, followed by the Hybrid-Owned, and then Option 4 as the least value.

7.4.2.2 Cumulative NPV of Cash Flows

A comparison of cumulative NPVs at 4, 5, and 30 year milestones from beginning of project in-service show the following:

	Year 4 Cumulative NPV of Cash Flow	Year 5 Cumulative NPV of Cash Flow	Year 30 Cumulative NPV of cash Flow
Totally Owned	$(39,370,084)	$(36,716,313)	$(31,193,898)
Primary Lease	$(26,345,127)	$(26,080,000)	$(38,971,472)
Hybrid Owned	$(30,905,677)	$(30,321,322)	$(42,765,673)
Option 4	$(25,824,648)	$(27,214,110)	$(46,625,663)

At year 4, net cash flow “bottoms” out and is included for reference. Year 5 is compared since it is at the end of the implementation period, and year 30 is included for a long-term view. Comparison of the values between year 5 and year 30 show how cash flow might improve over life of the assets, from the earlier years of the project where the net cash flow has more impact. These numbers indicate that in the short term, the Total Owned alternative requires the most cash, with Option 4 the least, and Hybrid-Owned and Primary Lease alternatives in between. In the later years, the opposite is true, with Total Owned the best, Option 4 the least, and Primary Lease and Hybrid Owned in between, however Option 4 tracks relatively close to the Hybrid Own value.

In summary, Option 4 can minimize cash outlay in the near term (< 4-5 years) if that is needed to meet Ameren’s financial requirements.

8. Conclusions and Recommendations

All indicators point to the Total Owned alternative still as providing the best long term value to Ameren. It provides best overall value and benefits to ratepayers, as shown from EVA/NPV/CPWRR model analysis. The Total Owned solution also provides a level of insurance in that it mitigates future risk if NERC tightens requirements on use of leased facilities for communications with critical transmission assets.

Results show that implementing Option 4 has a similar outcome to the Hybrid Owned alternative, but provides less value in total cumulative revenue requirements or cumulative NPV of cash flow in the later years. It does provide the advantage of minimizing CAPEX and OPEX outlay in the early years, and providing a more viable migration path to Total Owned (building a private backbone rather than leased), preferably timed to commence by years 8-10 when results show Total Owned to be the more long term cost-effective solution.

Option 4 would provide a private backbone transport that would be under Ameren control, compared to the Hybrid Owned which relies on a carrier leased fiber transport for primary backhaul. However sites off the private backbone would still be subject to leased facilities in local loops, identified to be an issue from a reliability standpoint.

Overall, the recommendation is to proceed with Option 4 rather than the Hybrid Owned alternative, if the long-term goal is to eventually migrate to the Total Owned solution.

Attachment 1: Baseline Sites Included in Option 4 Design

Attachment 2: Option 4 Existing Microwave, Timeplex, CODEX, and SONET Paths

Attachment 3: Map of Ameren Owned Communications Towers in Illinois

Attachment 4: Path Analysis of DS-3 and OC-3 Radios

Attachment 5: Office Proximity to Microwave Sites

Attachment 6: Option 4 Phases

Attachment 7: Site Costing Spreadsheets-Option 4

Attachment 8: EVA/NPV/ CPWRR Model spreadsheets – Option 4 Alternative