IT Project Proposal Report - Detail
Agency: 047 - EDUCATIONAL TELECOMMUNICATIONS COMM
Budget Cycle: 2011-2013 Biennium Version: AF - AGENCY FINAL REQUEST

IT Project : Satellite Replacement project

General Section

Contact Name :	Stacey Decker	**E-mail :**	sdecker1@unl.edu	**Agency Priority :**	1
Address :	1800 North 33rd Street	**Telephone :**	402-472-3611	**NITC Priority :**	
City :	Lincoln			**NITC Score :**	
State :	Nebraska	**Zip :**	68503		

Expenditures

IT Project Costs	Total	Prior Exp	FY10 Appr/Reappr	FY12 Request	FY13 Request	Future Add
Contractual Services						
Design	0	0	0	0	0	0
Programming	0	0	0	0	0	0
Project Management	0	0	0	0	0	0
Data Conversion	0	0	0	0	0	0
Other	0	0	0	0	0	0
Subtotal Contractual Services	0	0	0	0	0	0
Telecommunications						
Data	0	0	0	0	0	0
Video	0	0	0	0	0	0
Voice	0	0	0	0	0	0
Wireless	0	0	0	0	0	0
Subtotal Telecommunications	0	0	0	0	0	0
Training						
Technical Staff	0	0	0	0	0	0
End-user Staff	0	0	0	0	0	0
Subtotal Training	0	0	0	0	0	0

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Expenditures

IT Project Costs	Total	Prior Exp	FY10 Appr/Reappr	FY12 Request	FY13 Request	Future Add
Other Operating Costs						
Personnnel Cost	0	0	0	0	0	0
Supplies & Materials	0	0	0	0	0	0
Travel	0	0	0	0	0	0
Other	0	0	0	0	0	0
Subtotal Other Operating Costs	0	0	0	0	0	0
Capital Expenditures						
Hardware	0	0	0	0	0	0
Software	0	0	0	0	0	0
Network	0	0	0	0	0	0
Other	3,912,100	0	0	218,000	673,200	3,020,900
Subtotal Capital Expenditures	3,912,100	0	0	218,000	673,200	3,020,900
TOTAL PROJECT COST	3,912,100	0	0	218,000	673,200	3,020,900

Funding

Fund Type	Total	Prior Exp	FY10 Appr/Reappr	FY12 Request	FY13 Request	Future Add
General Fund	3,912,100	0	0	218,000	673,200	3,020,900
Cash Fund	0	0	0	0	0	0
Federal Fund	0	0	0	0	0	0
Revolving Fund	0	0	0	0	0	0
Other Fund	0	0	0	0	0	0
TOTAL FUNDING	**3,912,100**	**0**	**0**	**218,000**	**673,200**	**3,020,900**
VARIANCE	**0**	**0**	**0**	**0**	**0**	**0**

IT Project Proposal Report - Detail
Agency: 047 - EDUCATIONAL TELECOMMUNICATIONS COMM
Budget Cycle: 2011-2013 Biennium Version: AF - AGENCY FINAL REQUEST

IT Project: Satellite Replacement project

EXECUTIVE SUMMARY:

NET's current satellite lease that supports the broadcast service interconnection between the NET origination center in Lincoln and the State-owned and licensed transmitters and translators will expire in January 2012. Per Legislative approval and appropriation, the NETC commissioned a study conducted by Skjei Telecom to analyze current NET television, radio and educational distribution requirements, to investigate available distribution methods (e.g. satellite, fiber optic, and microwave), and to recommend a distribution system for the years 2012 thru 2022.

Four alternative primary means of distributing the NET programming in the 2012 - 2022 timeframe were investigated:

1. Satellite Transmission (as at present)
2. Fiber optic digital terrestrial distribution
3. Microwave transmission
4. Hybrid Network Nebraska fiber plus "last mile" microwave

The lowest cost alternative meeting NET's requirements is the fiber optic alternative. Therefore, the Nebraska Educational Telecommunications Commission is making a capital request of $3,912,100 over the State of Nebraska's next five biennium budgets to support ten years of interconnection requirements:

Item:	FY2012	FY2013	FY2014	Next 7 Yrs
Satellite Lease	$218,000	$523,200	$523,200	0
Fiber Lease	0	0	$148,200	$2,074,800
Non-recurring capital costs	0	$150,000	$274,700	0
Total	$218,000	$673,200	$946,100	$2,074,800

This would save approximately $404 K over the next best option over the 10 year life of the project.

The complete Skjei Telecomm report has been included for the reviewers.

Attachments:

Skjei Telecom study NET Alternatives 8-16-10.pdf

Satellite Replacement Project - NITC form 9-2010.doc

GOALS, OBJECTIVES, AND OUTCOMES (15 PTS):

The purpose of this project is to analyze current NET Television, Radio and Educational distribution requirements, to investigate available distribution methods (e.g. satellite, fiber

optic, and microwave), and to recommend a distribution system for the years 2012 thru 2022 which will replace the present satellite interconnection to NET transmitters across the state. Measurable outcome is the continuation of statewide public radio and television service. Without an interconnection plan, service at the transmitters would cease and NET and the State would lose the radio and television licenses. Statewide broadcast is a statuatory requirement. This project is the single most important component of the agency's mission and resulting technology plan.

PROJECT JUSTIFICATION / BUSINESS CASE (25 PTS):

NET management plans include two strategic decisions: first, to maximize efficiency of the television and radio broadcast spectrum, and - second – to take full advantage of the Network Nebraska partnership, both in terms of controlling costs through Network Nebraska's ability to aggregate costs and in delivering educational services over existing fiber networks instead of by satellite. These decisions reduced the amount of bandwidth NET would need to deliver the broadcast services to NET's transmitters.

Our recommendation is to transition NET's retransmission service from satellite to fiber delivery over the next four years. NET will reduce its satellite capacity by 75%, but will retain all existing television and broadcast services. Existing fiber connections in Lincoln and Omaha will provide further programming streams to be available to the state's two largest communities at no additional cost. The cost of this solution, including approximately $425,000 of non-recurring build-out expenses, is $3,912,000. The ten-year (twelve years of service) price of the previous satellite retransmission contract was over $28 million. By adopting this new strategy, no NET service will be lost and the State will realize over two million dollars per annum in cost avoidance savings. The switch to fiber delivery should also result in reduced maintenance costs and allow for potential efficiencies in collaboration with the CIO's office and the State Division of Communications.

Four interconnection strategies were considered. See attached Skjei Telecomm analysis for details. Without an interconnection plan, service at the transmitters would cease and NET and the State would lose the radio and television licenses. NET's primary requirement in state statute is to provide a statewide radio and television broadcast service. Without an interconnection solution, there is no alternative for originating broadcast content at the transmitters – which means the federal licenses would need to be vacated.

TECHNICAL IMPACT (20 PTS):

The transmission data rate required is 25 Mbps in one direction only, from NET Lincoln to the UHF/VHF transmitters. This allows for the 19.4 Mbps digital television signal, approximately 4% IP overhead, and an allowance for forward error correction. See attached Skjei Telecomm analysis for complete technical requirements, and comparison with other potential solutions. As the proposed solution is a migration plan for full interconnection within Network Nebraska, the project is fully compatible with existing infrastructure and NITC technical standards. Reliability, security and scalability are determined by the measurements of Network Nebraska capabilities and performance.

PRELIMINARY PLAN FOR IMPLEMENTATION (10 PTS):

Project management will be shared by NET engineering staff, led by Assistant General Manager of Technology (Stacey Decker), the Office of the CIO, and Network Nebraska administrators.

- Establish the short term (2012-2014) Satellite lease - June 2011
- Develop a transition plan and schedule - June 2012
- Develop equipment specifications for capital equipment purchase - June 2012
- Begin staff training – June 2012
- Prepare a deliverables and requirements outline for Fiber contracts - June 2012
- Establish fiber contracts with OCIO – June 2013
- Build out – December 2013
- Operate simultaneous Station to transmitter links - Dec-June 2014
- Transition to fiber delivery – June 2014

The transition to a fiber delivery structure will require NET technical staff to be trained in this field. While we have experience in fiber communications the limited work load is generally managed by 2-3 personnel. This expertise in house does however allow us to cross train current staff to fulfill the needs of the organization. This will include training on fiber radios as well as installation and test gear. This training will begin June of 2012.

The requirement for support on fiber infrastructure will remain much like our current Satellite needs. NET will rely on an established relationship with the OCIO for support on fiber specific issues but will support fiber delivery gear independently. Ongoing Maintenance costs of fiber delivery equipment has not been determined but is not expected to exceed 10% of the total equipment investment of 150k.

RISK ASSESSMENT (10 PTS):

Audiences that receive NET's services by satellite (primarily out-of-state viewers and listeners, and five small cable distributors) will lose service when the full transition to fiber interconnection takes place. As these audiences are not core to the mandate of the NETC statutes, the risk and loss of service was considered less important than the cost avoidance advantages of the proposed solution. Loss of service and resulting downtime due to fiber failure is greater than the satellite solution.

NET is implementing an over-the-air 'repeater' strategy to address the potential downtime issue. The idea is to take an off-air signal from a neighboring transmitter – beginning with KUON – and repeating the broadcast to the next tower/transmitter site. This strategy is susceptible to weather and distance factors, but core service to Lincoln, Omaha, Norfolk and the I-80 corridor should be protected in most circumstances.

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FINANCIAL ANALYSIS AND BUDGET (20 PTS):

See attached spreadsheet.

Attachments:

Satellite replacement cost analysis 8-2010.xlsx

NEBRASKA EDUCATIONAL TELECOMMUNICATIONS COMMISSION
SATELLITE REPLACEMENT COST COMPARISONS FY2012 thru FY2021
August 18, 2010

FY2012:	Description	Period	Monthly Rate	Cost
February 2012 - June 30, 2012	Satellite Lease	5 months	$43,600	$218,000
FY2013:				
July 1, 2012 - June 30, 2013	Satellite Lease	12 months	$43,600	$523,200
Initial capital investment	At NET			$150,000
Total FY2013 request				$673,200
FY2014:				
July 1, 2013 - June 30, 2014	Satellite Lease	12 months	$43,600	$523,200
January 1, 2014 - June 30, 2014	Fiber Lease	6 months	$24,700	$148,200
Initial capital investment	Build out of Nebr Network			$274,700
Total FY2013 request				$946,100
FY2015 thru FY2021 (7 fiscal years):				
July 1, 2014 - June 30, 2021	Fiber Lease	84	$24,700	$2,074,800
Total Satellite Replacement request for FY2012 thru 2021				$3,912,100
Total term: 9 years, 5 months				
February 2012 - June 30, 2021	Satellite Lease	113 months	$38,200	$4,316,600
Total Savings				$404,500
Total Historical Costs:				
February 2000 - January 2012 (12 years lease paid over 10 years)	Satellite Lease	120 months	$237,100	$28,452,000
Savings for 10 year term				$19,797,900
Savings per year				$1,979,790
Savings for 1/2 Transponder over 10 year term				$2,015,400
Savings for 1/2 Transponder per year				$201,540

NET Distribution Alternatives 2012-2022

August 16, 2010

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Table of Contents

Executive Summary

This document reports the results of a study conducted by Skjei Telecom for the Nebraska Educational Telecommunications Commission (NETC) during March thru August of 2010. The purpose of this study is to analyze current NET Television and Radio and Educational distribution requirements, to investigate available distribution methods (e.g. satellite, fiber optic, and microwave), and to recommend a distribution system for the years 2012 thru 2022.

Four alternative primary means of distributing the NET programming in the 2012-2022 timeframe were investigated:

- Satellite Transmission (as at present)
- Fiber optic digital terrestrial distribution
- Microwave transmission
- Hybrid Network Nebraska fiber plus "last mile" microwave

The transmission data rate required is 25 Mbps in one direction only, from NET Lincoln to the UHF/VHF transmitters or other end users. This allows for the 19.4 Mbps digital television signal, approximately 4% IP overhead, and an allowance for forward error correction. In the future, it will no doubt be possible to reduce this through the use of advanced modulation techniques such as MPEG 4 AVC, but for the 2012 time frame, MPEG 2 transmission, as presently used, is the conservative assumption.

The lowest cost alternative meeting NET's requirements is the fiber optic alternative, which is recommended. This alternative requires approximately $425K ($425,000.00) for non recurring start up costs for telecom equipment, facilities and hardware to convert to an IP delivery system, and equipment installation. This fiber optic solution would save approximately $593 K over the 10 year life of the contract, and is the recommended solution (note time value of money is not included in this savings. This figure includes the increased satellite lease cost for the first 2 years during the transition period plus 6 months of actually duplicated (satellite plus fiber) service during transition.

Although this solution would result in loss of service to many or most out-of-state viewers, and to approximately 5 communities within the state, there are mitigating factors discussed in the body of the report.

Another advantage of the fiber optic solution is that it allows a two way transmission path solution to the 9 transmitter sites at very little additional cost. (At the present time NET brings confidence monitoring and control feedback signals from some transmitter sites at additional cost.) Selecting the fiber optic alternative with the inherent return path would allow NET to save money by eliminating those feedback circuit costs.

Introduction

This document reports the results of a study conducted by Skjei Telecom for the Nebraska Educational Telecommunications Commission (NETC) during March thru August of 2010.

Purpose of the Study

The purpose of this study is to analyze current NET Television, Radio and Educational distribution requirements, to investigate available distribution methods (e.g. satellite, fiber optic, and microwave), and to recommend a distribution system for the years 2012 thru 2022.

Changes since the 1998 Study

In 1998 Skjei Telecom performed a study for NETC which was similar in scope to the present study. The results were to recommend long term lease of two C Band satellite transponders.

Since 1998, however, numerous changes have occurred both to NET's role and mission and to the telecommunications services environment available in Nebraska:

- Several of NET's former mission areas have been eliminated: two way videoconferencing, satellite borne educational services; CATV dedicated television channel, for example. These have significantly reduced the bandwidth required for distribution.
- HD Radio has been implemented statewide and requires a small amount of additional bandwidth.
- Several former NTSC analog channels have been consolidated into one digital television transport stream
- On the supply side, fiber optic telecommunications paths have increased significantly throughout the state, eliminating many former microwave and coaxial cable paths.
- A technique known as Wavelength Division Multiplexing (WDM) has increased the capacity carrying capability of existing fiber optic cables.
- The cost of C Band satellite transmission has been reduced.
- Cable Television service providers have formed fiber optic networks for purposes of distributing digital television to multiple sites. These networks are beginning to offer commercial service as well.

Approach Followed

This assessment began with a review of the previous effort and its sources. Updates were then obtained by various means, including personal interviews, the internet and telephone calls.

A review of the current state of NET's broadcast posture was conducted, taking into account the recent change from analog television transmission to digital television format.

Availability of terrestrial fiber was determined and numerous carriers and Cable TV (CATV) providers were contacted and interviewed to discuss their networks.

Future trends in the area of broadcasting, terrestrial fiber infrastructure, and NET plans were assessed.

At this point it was possible to develop a specification for the NET distribution requirements. This specification is at Appendix A and discussed in greater detail in the following section.

It was possible to assess four alternative primary means of distributing the NET programming in the 2012-2022 timeframe:

- Satellite Transmission (as at present)
- Fiber optic/copper digital terrestrial distribution
- Microwave transmission using either state owned or leased towers, etc.
- Hybrid Network Nebraska fiber plus "last mile" microwave

The specification was distributed to multiple service providers and numerous quotes were obtained for each location. It became necessary to define a new concept of operations for this distribution system, when it was realized that the office of the Nebraska State Chief Information Officer would take on a primary role in the event that a fiber optic distribution system were selected.

Discussions with the CIO's office then occurred and it was realized that should a terrestrial network be selected, the CIO would choose to integrate the NET distribution into its current fiber optic telecommunications infrastructure, known as Network Nebraska. The existing Network Nebraska facilities and paths would be expanded and "spurs" added to them to reach the required destinations. At this point the CIO's office took the lead in obtaining quotations for fiber optic distribution, using its existing internet web site.

During the course of this study, numerous parties were interviewed in person and a large number of telephone discussions took place with telecom service providers, NET customers (e.g. Cable TV and small Telcos), NET and University of Nebraska personnel.

Distribution Technical Requirements

The specification provided to bidders is at Appendix A. This section describes that document.

Bandwidth

The data rate required is 25 Mbps in one direction only, from NET Lincoln to the UHF/VHF transmitters or other end users. This allows for the 19.4 Mbps digital television signal, approximately 4% IP overhead, and an allowance for forward error correction. In the future, it will no doubt be possible to reduce this through the use of advanced modulation techniques such as MPEG 4 AVC, but for the 2012 time frame, MPEG 2 transmission, as presently used, is the conservative assumption.

Performance Requirements

The following highlight the major performance requirements;

Data Transport Methods

No specific transport method is called for. Multiprotocol Label Switching (MPLS), 1 or 10 Gigabit per second Ethernet, Synchronous Optical Network (SONET) or straight data transmission (no transport layer) may be used. For fiber optic transmission, multicast will be implemented within the Network Nebraska framework.

Availability

Consistent with the current satellite network, a network availability of 99.995% is required. Availability is defined as the total number of minutes each day during which the circuit meets all other requirements, including a Bit Error Rate of one error in 10^9 bits.

Network Latency

On an end to end basis (Lincoln to transmitter, for example) a differential latency of less than 1 second is required among all end-points so that network timing is maintained for various locations within the state. Absolute latency is not a primary concern, as long as the latency is consistent: absolute latency can be adjusted at Lincoln. Since for fiber optic distribution a large portion of the transmission is within the Network Nebraska infrastructure, the 1 second latency is budgeted half to Network Nebraska and half to the tail circuits, or 500 milliseconds to each portion.

Mean Time to Restore

The mean time to restore measurement for a service is defined as the average time between the initiation of a trouble ticket and service restoration. The MTTR objective changes depending upon the severity of the problem. For a complete outage severity 1), 4 hours MTTR is required, whereas for minor degradation not affecting service (severity 3) a 24 hour MTTR is sufficient.

Jitter

Consistent with general industry standards for digital video, less than 40 ms jitter is required.

Monitoring and Quality of Service

Network monitoring is required at all times. Actual repair of the circuit, not just restoration, is required within 4 hours of circuit restoration.

Broadcast Signal Recipients

Two categories of recipients of the NET originated television and radio broadcast signal were considered: UHF/VHF over the air transmitters and those CATV entities who today are only able to receive an adequate NET broadcast signal from the satellite. There may also be some individual Nebraska citizens who receive the signal from the satellite directly.

UHF/VHF Transmitters

Table 1 contains the list of television transmitter sites which need to receive the NET digital television signal. Presently, these sites receive the signal via satellite, in most cases.

Television Transmitter Site	Site Address	City	Zip Code
KLNE TV	72821 J Road	Holdrege	68949
KMNE TV	86304 Eagles Nest Ave	Bassett	68714
KPNE TV	12392 South Highway 25	Sutherland	69165
KRNE TV	17 miles S Highway 61	Merriman	69218
KUON TV	851 County Road G	Ithaca	68033
KTNE TV	1/4 mi South intersect 103/118	Angora	69331
KXNE TV	56263 Highway 98	Carroll	68723
KYNE TV	60th & Dodge	Omaha	68128
KHNE TV	1105 W 6th Rd	Giltner	68841

Table 1: Television Transmitter Sites

CATV and Telco Service Providers

Today, many cable television and integrated telecommunications service providers (telephone, cable, internet) obtain their NET signal using a satellite antenna and a digital receiver known as an IRD (integrated receiver decoder). They do this for two reasons:

1. The over-the-air VHF or UHF television signal is not available in the quality required for cable distribution
2. The cable operator wishes to take advantage of the satellite signal's 24 hour presence, as opposed to the 16 hour broadcast day provided by the terrestrial UHF and VHF transmitters.

Initially 30 CATV locations were identified which would benefit from provision of a signal other than the over-the-air transmission. These providers were generally contacted via telephone and confirmed their interest in receiving such a fiber optic broadcast feed, under the assumption that it would be provided at no monthly cost, as is the current situation using a satellite feed.

It was then realized that the cost of providing a broadcast fiber optic feed to these locations would not be trivial. An effort was then made to reduce the number of sites requiring this feed, and telephone calls were once again made to these providers. As a result, the number of sites who would actually require a fiber optic feed (in order to provide adequate quality NET service to one or more Nebraska communities) was reduced to 5 locations. These sites are listed in Table 2

Company	Head End	Served Area
Great Plains	Trenton, NE	Trenton, NE
Cable One	Sioux City, IA	Sioux City, NE; Dakota City, NE
PC Telecom	Holyoke CO	Chappell, NE
Nebraska Central	Burwell, NE	Burwell NE
Three Rivers	Ainsworth, NE	Ainsworth, NE

Table 2: CATV Sites Unable to Receive Adequate Quality using Over-air (UHF) Reception

Alternative Methods of Distribution

There are three primary and one hybrid methods whereby the NET transmitters, and in some cases the CATV head ends, could receive the NET broadcast television and radio signal

Satellite

At the present time, NET distributes its signal to most transmitters and many CATV head ends via satellite. This is the Galaxy 28 satellite located at 89 degrees west longitude. Two C band transponders are used. The signal is available 24 hours each day.

While NET provided all the transmitter sites with satellite equipment, only 6 CATV sites were provided receivers by NET (note: these are not the CATV sites in Table 2); the remaining sites procured their own receivers.

As mentioned previously, due to the reduction in scope of NET's mission, two transponders are no longer required to distribute the broadcast signal; a one half transponder bandwidth would be sufficient for the time frame considered by this study. A link budget for this transmission is provided in Appendix B.

Satellite bandwidth quotations were obtained from two sources: SES-Americom and PBS, for costing this alternative. The quotations were very competitive, due to an oversupply of capacity in the C Band satellite market.

Satellite cost quotations are contained in Table 3 below. Only the most favorable cost quotation is shown.

A quote for pre emptible service is included due to its low cost, but it is not recommended until/unless NET is successful in implementing an off-back up method to be employed in the event of satellite failure. Today, the C band satellite market is such that a pre-emptible grade of service is not particularly risky. This is because the value of a C band customer is so high that satellite service providers will restore any failed C Band service almost immediately in order to keep the customer's revenue stream, and excess capacity generally exists to accomplish this.

A 2 year quote is also included for use in transitioning to another distribution method, since such a transition would take time to accomplish.

Grade of Service	Bandwidth	Term	Monthly Lease Fee
Transponder Protected (Inter-satellite protected)	18 MHz	10 Years	$38.2 K
Pre-emptible	18 MHz	10 Years	$35.1 K
Transponder Protected (Inter-satellite protected)	18 MHz	2 Years	$43.6 K

Table 3: AMC-9 Satellite (83^{o} West Longitude) C Band Pricing

Microwave

Prior to distributing its signal via satellite, NET utilized a state wide microwave network for this purpose. Such networks have had mixed success over time and geography. At alternate times, they are used to replace other methods (such as satellite), or they themselves are replaced by other methods such as satellite or fiber optic.

The advantages that microwave networks have are that they often can share tower space with other services, such as radio transmitters, highway department or forestry department transmitters. The disadvantages generally involve maintenance costs for towers and equipment.

For this study, the design of the former NET microwave network was used as a basis for costing. Table 4 contains the cost elements for this network.

Table 4 assumes a network consisting of 4 all new towers and 10 towers shared with other state entities.

	One Time Capital Cost ($K)	Monthly Recurring Cost ($K)
Towers	$1300 K	
Radio Equipment	1320 K	
Building, Generator	230 K	
Install and remove	$430 K	
Land Lease		$6.5 K
Electric, Telephone, Water		5.8 K
Technical Maintenance		23.8 K
Physical Maintenance		5.4 K
TOTALS	**$3280 K**	**$ 41.5 K**

Table 4: Microwave Network Costs

Fiber Optic Lines

With the assistance of the CIO's office, quotes were obtained from several existing and planned Nebraska service providers for 25 Mbps IP connectivity from Network Nebraska to locations listed in Tables 1 and Table 2. The results are shown in Table 5 and include a $186 per link Network Nebraska tariff. At least 6 bids were received for each site. In order to use this IP distribution method, new hardware is required amounting to a one time capital cost of approximately $150 K for format conversion equipment. This is also shown in Table 5.

	Non-Recurring Cost	Monthly Recurring Cost
9 Transmitter Sites		
25 Mbps IP Service	$274.7 K	$23.0 K
NET Hardware Upgrades	$150.0 K	
Network Nebraska Tariff		1.7 K
Total: Transmitter Sites	**$424.7 K**	**$24.7 K**
5 CATV Head Ends		
25 Mbps IP Service	$7.8 K	$32.8 K
Hardware Upgrades	0	
Network Nebraska Tariff		$ 0.9 K
Total CATV Head Ends	**$7.8 K**	**$33.8 K**

Table 5: Fiber Optic Network Costs

Hybrid Fiber Optic/Microwave

One hybrid option for broadcast distribution currently being used in other states is a combination of fiber optic trunking and microwave tail circuits for "last mile" distribution. This option would leverage the existing or slightly expanded Network Nebraska and use microwave for the "last mile" type connectivity to the actual transmitter site. It was estimated that 3 new microwave repeaters and 5 shared repeaters would be required for this connectivity. Costs are shown below in Table 6. Connectivity to the CATV head ends is not provided.

	One Time Capital Cost ($K)	**Monthly Recurring Cost ($K)**
Towers	$ 975 K	
Radio Equipment	740 K	
Building, Generator	135 K	
Install and remove	$260 K	
Land Lease		$4.2 K
Electric, Telephone, Water		3.5 K
Technical Maintenance		13.6 K
Physical Maintenance		3.6 K
Network Nebraska Connectivity		**1.5**
TOTALS	**$2110 K**	**$ 26.4 K**

Table 6: Hybrid Fiber Optic and Microwave Network Costs

Comparison of Alternatives

Table 7 provides a comparison of the costs for the various methods for the transmitter sites.

All of these methods are capable of providing adequate quality service, however only the existing method, satellite delivery, requires minimal additional effort or reconfiguration to implement. All other methods would require a lengthy transition period, estimated at 2 years, to implement.

	Non Recurring	Monthly Recurring
Satellite	0	$ 38.2 K
Microwave	$3280 K	$ 41.5 K
Fiber Optic	$ 425 K	$24.7 K
Microwave + Fiber Optic	$2110 K	$26.4 K

Table 7: Comparison of Costs for Distribution to 9 UHF/VHF Transmitter Sites

Clearly, the lowest cost alternative is the fiber optic alternative. This alternative does require approximately $425 for non recurring start up costs to build facilities, to obtain hardware to convert to an IP delivery system, and to install equipment.

Another advantage of the fiber optic solution is that it achieves a two way solution at very little additional cost- mostly hardware. At the present time NET brings confidence monitoring feedback signals from the transmitter sites, and using the fiber optic method with the inherent return path would allow NET to save money by eliminating those feedback circuit costs.

It should, however, be pointed out that selecting the fiber optic solution would result in a number of CATV sites out of state losing the NET signal. A fairly large number of cable head ends in South Dakota and Iowa were not included in this study because they do not support viewers within the State of Nebraska. If the fiber optic solution is selected these viewers would lose the NET signal.

It is also worth pointing out that a number of CATV sites would be disappointed that they no longer had a 24 hour NET signal but only a 16 hour signal. There might be pressure on NET to transmit 24 hours per day, and this would result in additional expense. This would certainly be the case if NET were to decide to provide DirecTV or Dish network with a 24 hour signal (at present both satellite providers only receive an off air signal with a 16 hour feed)

Table 8 provides a comparison of the costs for the transmitter sites and the CATV sites.

	Non Recurring	Monthly Recurring
Satellite	0	$ 38.2 K
Microwave	N/A	N/A
Fiber Optic	$ 432 K	$ 58.4 K
Microwave + Fiber Optic	N/A	N/A

Table 8: Comparison of Costs for Distribution to 9 UHF/VHF Transmitter sites and 5 CATV Head Ends

CATV sites included in Table 8 are only those who serve viewers within the State of Nebraska and have indicated that they cannot receive an adequate quality signal using exclusively off-air methods. That said, none of these sites provided amplifying information, test data or initiated special tests to validate that assertion. If NETC decides that it is necessary to provide signals to these CATV sites, and to

others not included (such as out of state and those desiring a 24 hour feed) the satellite solution is clearly more cost effective.

Transition Considerations

If the fiber optic solution is selected, it is worth nothing that a lengthy transition period would be required. It is estimated that two years would be required to implement all the terrestrial circuits to the transmitter sites and to revise operational procedures for provide a high availability signal. Fiber Optic service providers would have to be trained to provide service 24 hours a day, 365 days per year. At present, most of these service providers reduce or even eliminate staffing on weekends and Service Level Agreements would have to be clear on mean time to restore service following a failure.

Summary and Recommendation

In view of the fact that the fiber optic solution to provide the NET signal to the 9 transmitter sites (only) would save approximately $593 K over the 10 year life of the contract, it is the recommended solution. This figure includes the half transponder satellite lease cost for the first 2 years during the transition period plus 6 months of actually duplicated (satellite plus fiber) service during transition.

Another advantage of the fiber optic solution is that it allows a two way transmission path solution to the 9 transmitter sites at very little additional cost. At the present time NET brings confidence monitoring and control feedback signals from some transmitter sites at additional cost. Selecting the fiber optic alternative with the inherent return path would allow NET to save money by eliminating those feedback circuit costs.

Although this solution would result in loss of service to most out of state viewers, and to 5 communities within the state, there are several mitigating factors. First, the CATV providers denied adequate service may in fact find that they are able to obtain service via other methods. CATV providers are very aggressive in linking different geographical areas of the state by fiber optic, even when different companies are involved. Also, the five areas mentioned did not perform a rigorous analysis to see if the NET signal might be available via other means. Finally, it is not out of the question that during the time period involved NET may have an adequate quality signal streaming on the internet or other fiber network.

Appendix A: Performance Specification

NET Distribution Service Specification

V 0.01

June 29, 2010

VENDOR will provide 25.0 or greater Mbps IP connectivity to each address listed in Attachment A ("Site").

VENDOR will provide a dedicated service for NET using Multi-protocol Label Switching (MPLS), Gigabit Ethernet, or SONET connectivity.

VENDOR will deliver service from an existing Network Nebraska node (see listing in Attachment B) to each Site via fiber optic cable, coaxial cable or wireless/microwave link, and will terminate into an Ethernet Interface Controller or similar device at the Site. VENDOR will provide, own, install and manage the terminal equipment at each node and site. An RJ-45 (copper/electrical) GBIC or similar interface on the terminal equipment will be provided by Vendor.

VENDOR and affiliates will provision single-path entrances to each Site and node and preferably connect to ring architecture at the closest economically feasible point for purposes of redundancy.

End-to-End Network Availability required is 99.995%. Availability is defined as the total number of minutes in a day during which a circuit is available (no outage) to deliver data from any node to any Site, divided by the total number of minutes in a 24 hour period. Outages include, but are not limited to, periods of service degradation, such as slow (Less than 25 Mbps) data transmission, excessive jitter, excessive latency or worse than 1×10^{-9} specified Bit Error performance. Note: incorrectly ordered packets are equivalent to errored bits

Network Latency required is less than 500 ms from the Network Nebraska node to any Site served. Latency is defined as the one way period of transmission time between the Network Nebraska interfaces at the node to the 25 Mbps user interface at the Site.

The Mean Time to Restore (MTTR) measurement for a service is the average time between the time VENDOR opens a Customer trouble ticket (Customer notifies VENDOR) and the time the service is restored. The average is calculated on all trouble tickets with the same severity level associated with the same network interruption.

There are four priority levels of trouble ticket severity (Critical, Major, Minor, and Informational).

MTTR Objective:

Severity 1 – Critical	Average within 4 hours
Severity 2 – Major	Average within 8 hours
Severity 3 – Minor	Average within 24 hours
Severity 4 – Informational	Not Measured

The following table represents daily performance requirements:

Parameter	Requirement
Service Availability (per day)	> 99.995%
Bit Error Rate (note: incorrectly ordered packets are considered to be errored bits)	Better than 1 bit error in E^9 bits
Maximum Latency End to End (node to Site)	500 ms
Jitter	<40 msec
Network Monitoring, Proactive Notification	24x7x365
Mean Time to Respond	30 Minutes
Mean Time to Respond Update	2 Hours
Mean Time to Repair	4 Hours

Appendix B: Satellite Link Budgets

NET DIGICIPHER MULTIPLEX

7/22/2010 SMSKJEI

FROM: LINCOLN TO: NEBRASKA

REQUIREMENTS			SATELLITE		
Availability	(%):	99.999	*Satellite		AMC-9
*Required Eb/No	(dB):	7.15	Satellite West Long	:	83.0
*Bit Error Rate	:	E-09	*Transponder	36 MHZ	C BAND
*Modulation Type	:	QPSK	!Usable Trnspndr BW (MHz):		36.00
*Info. Rate	(Kbps):	23600.00	!SFD @ 0 dB/K (dBW/M^2):		-95.00
*FEC Rate	:	0.81	*Transponder Atten (dB):		6.0
*					

TRANSMIT E/S			RECEIVE E/S		
North Lat: 42.0	West Long:	97.0	North Lat: 42.0	West Long:	97.0
Frequency	(GHz):	6.18	Frequency	(GHz):	3.95
*Satellite G/T	(dB/K):	2.50	*Satellite EIRP	(dBW):	39.20
*Antenna Diameter	(m):	4.5	*Antenna Diameter	(m):	4.5
Antenna Gain	(dBi):	46.70	Antenna Gain	(dBi):	44.00
Antenna Elevation	(Deg):	39.46	Antenna Elevation	(Deg):	39.46
Carrier EIRP	(dBW):	63.20	*LNA Noise Temp	(K):	35.00
*Power Control	(dB):	0.00	*Loss betw.LNA & Ant.	(dB):	0.05
*Output Circuit Loss	(dB):	2.00	System Noise Temp.	(K):	68.76
Path Loss	(dB):	199.84	Station G/T	(dB/K):	25.63
Other Losses	(dB):	0.70	Path Loss	(dB):	195.96
(other loss = atm,pol,ant point)			Other Losses	(dB):	0.60

INTERFERENCE

C/Io Adj Sat U	(dB-Hz):	102.03	#C/Io Intermod	(dB-Hz):	95.51
C/Io Adj Sat D	(dB-Hz):	97.40	C/No Thermal Up	(dB-Hz):	93.76
C/Io Crosspol	(dB-Hz):	109.03	C/No Thermal Dn	(dB-Hz):	89.87
C/Io Adj Channel	(dB-Hz):	108.43	C/Io Total	(dB-Hz):	92.49
C/Io Adj Trans	(dB-Hz):	111.13	C/No Therm Total	(dB-Hz):	88.38
C/Io Microwave	(dB-Hz):	115.52	C/No Total	(dB-Hz):	86.96

RAIN ATTENUATION

Overall Link Margin	(dB):	6.08	*Rain Model	:	CRANE
Uplink Availability	(%):	99.999			
Rain Margin	(dB):	6.08	*Uplink Rain Zone	:	D1
Dnlink Availability	(%):	99.999			
Rain Margin	(dB):	3.31	*Dnlink Rain Zone	:	D1
G/T Degradation	(dB):	5.12			

TRANSPONDER			H.P.A		
*Number of Carriers	:	MULTIPLE	*Number of Carriers	:	1.0
*Total OPBO	(dB):	4.00	*Total HPA OPBO	:	2.00
Total IPBO	(dB):	5.57	HPA Power/Carrier	(dBm):	48.50
*Carrier OPBO	(dB):	7.00	Required HPA Size	(dBW):	20.50
Carrier IPBO	(dB):	8.57	Required HPA Size	(W):	112.14

FCC Req: 1) Uplink Flange Density	(dBW/4kHz):	-19.14	File:	AMC9NET1
(@40.8) 2) Downlink EIRP Density	(dBW/4kHz):	-1.78		
Transponder BW Used Per Carrier (x1.25)	(%):	50.67	# = deltas used	
Transponder Power Used Per Carrier	(%):	50.12	! = modif. default	
Transponder Bandwidth Allocation	(MHz):	18.242	* = user's input	