State of Kansas
Network Consolidation Feasibility Study

March 2007

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State of Kansas
Executive Summary

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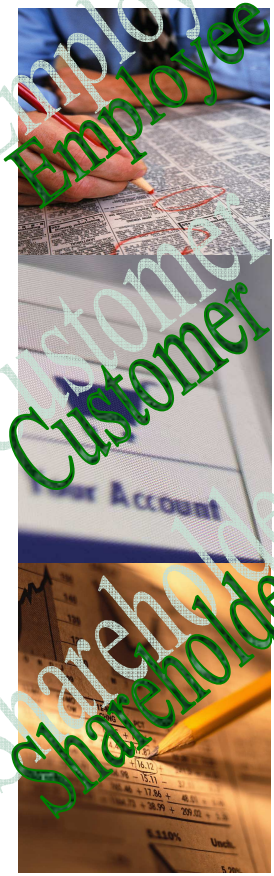
Objectives

- Support KanREN, KanWIN and Kan-ED in meeting the Kansas State Legislature's request to determine the feasibility of consolidating the 3 state networks
- Identify potential areas for network consolidation and areas for potential cost savings
- Identify additional investigation that will be required as "next steps" to exploring network consolidation
- Funding models have been excluded from this analysis
- Savings have been identified were quantifiable without detailed design and cost analysis



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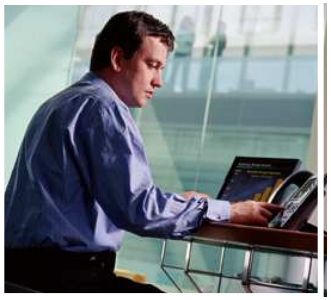
Business Drivers

Increased PRODUCTIVITY

- Collaboration
- Application Integration
- Mobility Service Enablement
- Response Time/Performance



Decreased COST

- Network Scale
- Simplification
- Staffing Economies
- Total Cost of Ownership (TCO)

Increased SECURITY/Integration

- Threats
- Loss
- First Response Support
- Public Safety

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Key Perspectives

- The three networks have distinguishing intra-network characteristics that preclude comprehensive consolidation
- All three networks have different governance structures and business models that result in varying operational considerations and regulatory requirements
- Multiple configurations of backbone networking and operation centers exist to accomplish similar purposes
- All three network have some synergies in regards to backbone configurations, network management, customer traffic aggregation and delivery of customer traffic
- KanREN, KanWIN and Kan-ED each provide valued services to their constituents in an efficient manner

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KanREN Network Summary

Business Environment

- Purpose
  - Broadband Technology-Based Network
  - Transport to Internet Access Points
  - Transport for internal applications and services
- User Communities
  - K-12, Higher Ed, Public Hospitals and Other Non-profit Organizations
- Applications
  - Interactive Distance Learning
  - Video Conferencing
  - Internet2
  - Public Internet
  - Access to State Applications
- Governance Model
  - 501(c)(3)
  - Board of Directors

IT Environment

- Backbone Speed
  - High speed core Star Topology backbone: Scalable to 1GB
- Network Access Points
  - Last-Mile circuits aggregated at 6 Access Points
- Network Scale
  - 50 members
  - 70 connected sites

KanWIN Network Summary

Business Environment

- **Purpose**
  - Broadband Based Network
  - Transport to Internet Access Points
  - Transport for internal applications and services
  - Transport for public government applications
- **User Communities**
  - State agencies, Local Gov and state residents
- **Applications**
  - Video, Public Internet, State Gov appls and E-Gov services
- **Governance Model**
  - Secretary of Administration and Policy Board

IT Environment

- **Backbone Speed**
  - Medium speed core backbone: 155MB
- **Network Access Points**
  - Last-Mile circuits aggregated at 3 Access Points
- **Network Scale**
  - 625 connected sites

Kan-ED Network Summary

Business Environment

- Purpose
  - Broadband Technology-Based Network
  - Transport for internal applications and services
- User Communities
  - K-12, Higher Ed, Libraries & Hospitals
- Applications
  - Interactive Distance Learning
  - Video Conferencing
  - Internet2
  - Telemedicine & EMR
- Governance Model
  - Kansas Board of Regents
  - Advisory Council

IT Environment

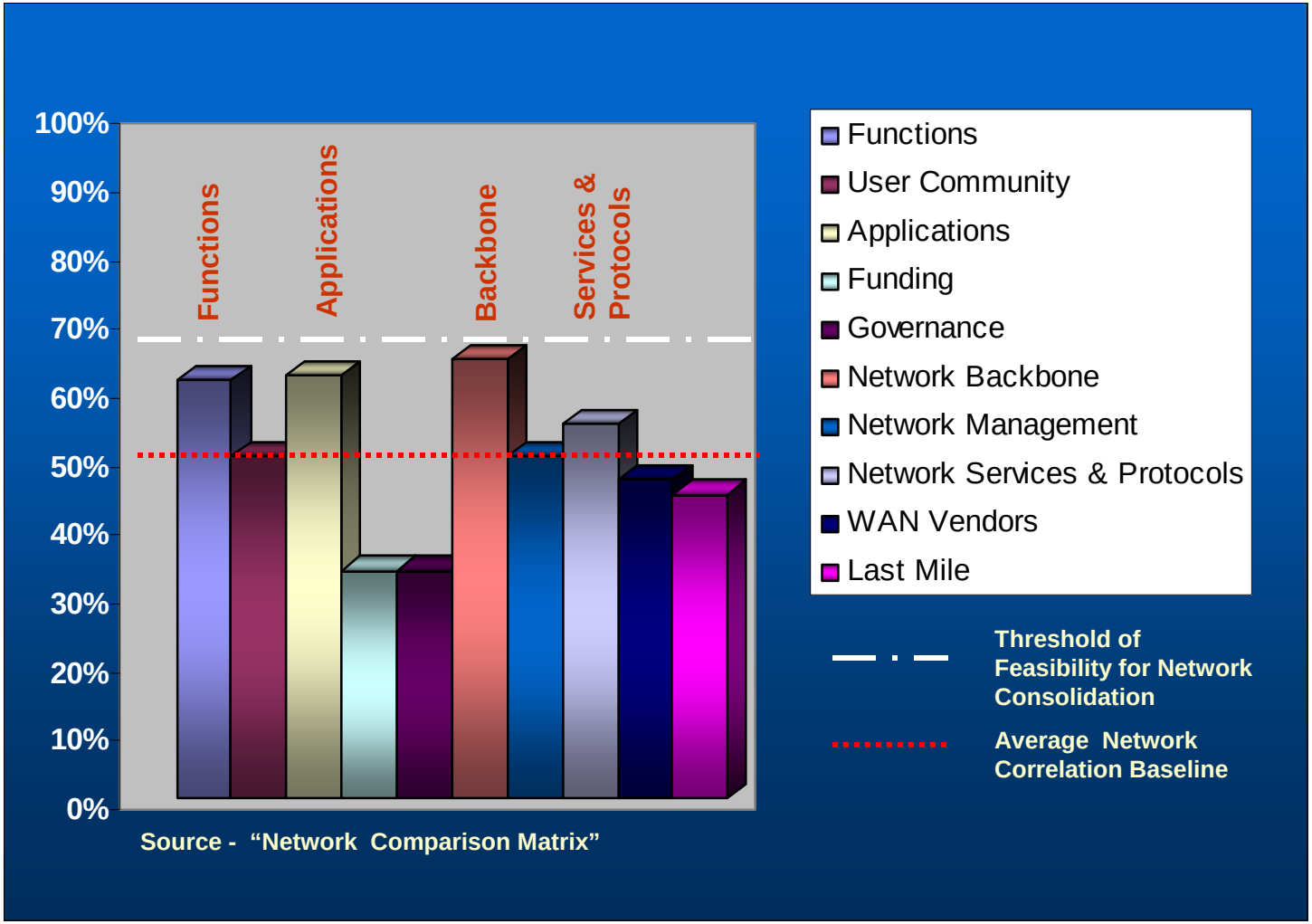
- Backbone Speed
  - Medium speed backbone: 155MB
- Network Access Points
  - Last-Mile circuits via Extended-Edge network aggregated at 19 Access Points
- Network Scale
  - 797 members
  - 298 connected sites (70 of which are connected via KanREN)

Key Observations

- A comparison of the three networks yielded the following observations regarding the feasibility of their consolidation
  - The three networks are most similar in their function, backbone, supported applications, and network services and protocols
  - The three networks also exhibit significant differences in these same areas
    - KanWIN requires a high level of security requirements when compared to the other networks
    - KanREN requires a high level of adaptability when compared to the other networks
    - Kan-ED and KanWIN exhibit similar requirements for high availability network services *
  - Other obstacles for consolidation include differences in funding and governance models

* Segments of the KanREN user community also have high availability requirements; however, its traditional role has been to provide a technologically leading-edge, dynamic environment for research purposes; these capabilities are incompatible with one another.

Threshold of Feasibility Illustration



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What We Found . . .

- **The three networks have distinguishing intra-network characteristics that preclude comprehensive consolidation**

  Security

  - **KanREN has an inherently open security policy due to its primary mission (research) and services (Internet and Internet2)**
  - **KanWIN has enterprise level security requirements due to federal privacy laws associated with the transported data and applications hosted on the network**
  - **Kan-ED also has a very open security policy due to the nature of the services provided to constituents**

  Availability

  - **KanREN has availability objectives but needs to balance them against the networks ability to adapt to user requirements**
  - **KanWIN has enterprise level availability requirements due to hosting applications that are mission critical to state agencies**
  - **Kan-ED has availability goals based on the nature of providing classes and telemedicine that are dependant on the network and video services being available**

What We Found . . .

- **Distinguishing characteristics (continued)**

  Standardization

  - **KanREN adheres closely to defined network designs and standards**
  - **KanWIN has recently gone under a detailed analysis which highlighted a lack of adherence/definition of network standards and documentation**
  - **Kan-ED adheres to no specific interconnect design or standard due to speed of delivery required by legislation**

  Governance

  - **KanREN is a private, non-profit organization whose participation would be voluntary**
  - **KanWIN and Kan-ED are governed by state institutions that can adapt statutory limitations to facilitate/mandate consolidation**

What We Found . . .

- **Distinguishing characteristics (continued)**

  Adaptability

  - **KanREN needs the flexibility to be an early technology adopter that is essential to support dynamic research institution requirements**
  - **KanWIN and Kan-ED require a more stable environment with predictable growth**

What We Found . . .

- **Kan-ED Specific Findings**

  Standardization and Complexity

  - Mandated speed of deployment limited ability to define clear Service Provider connection standards
  - Lack of defined connection standards introduced many compromises with how Kan-ED integrated with Service Providers
  - Avoidance of Kan-ED provided Internet services has contributed to additional complexity in Service Provider connections

  Low Backbone Utilization

  - Kan-ED data content is primarily accessed via the Internet
  - Few end users can access Kan-ED due to limited integration between Kan-ED and member's local area networks
  - Network patterns indicate significant traffic is localized within specific NAPs

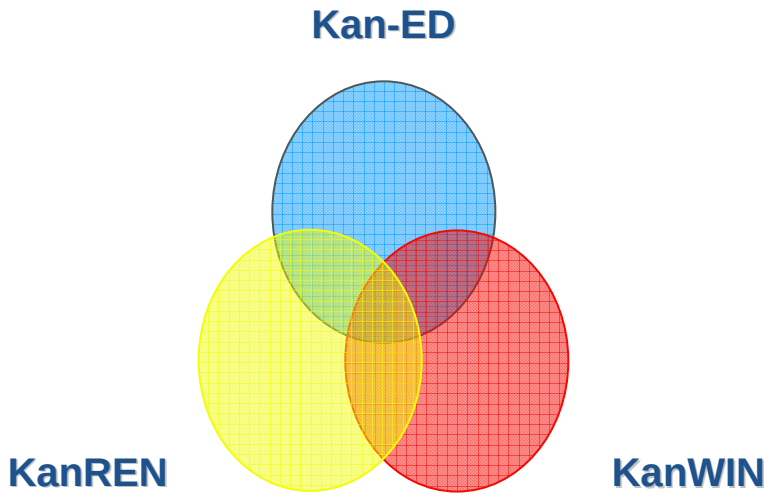
What We Found . . .

- **Kan-ED Specific Findings**
  - Video Overlay Network
    - Many Kan-ED connections terminate directly into video equipment
    - Video services are deployed at 170+ locations
    - Video classrooms are not architecturally efficient
      - 4 Video Endpoints
      - 4 Monitors
      - Multiple network connections required
      - Video endpoints are configured with a bit-rate of 768K (384K meets the industry standard for business quality)
      - Next-generation technologies are not leveraged to achieve operational economies or enhanced performance opportunities such as:
        - » H.264 video compression enables video conferencing users to experience either significantly improved video quality at the same bit rate, or current quality at approximately half the bit rate required previously (e.g. 768K video quality with a H.264 configuration that only requires 384K)
      - High cost maintenance model

Network Consolidation Overlay

A statewide comprehensive network consolidation approach is not feasible--it would keep each organization from meeting the requirements of their respective constituents. Specifically, this approach would not be prudent as a result of:

- ✓ **Diverse network business model requirements and rigorous security constraints**
- ✓ **Exorbitant financial and resource investments required**
- ✓ **A parallel network infrastructure would be required, which is not practical at a statewide level**
- ✓ **A cost benefit analysis would indicate an extended ROI payback period beyond a reasonable level of acceptance and cost recovery**



However segments of each network's infrastructure and technology can be leveraged as cost-effective shared utility services

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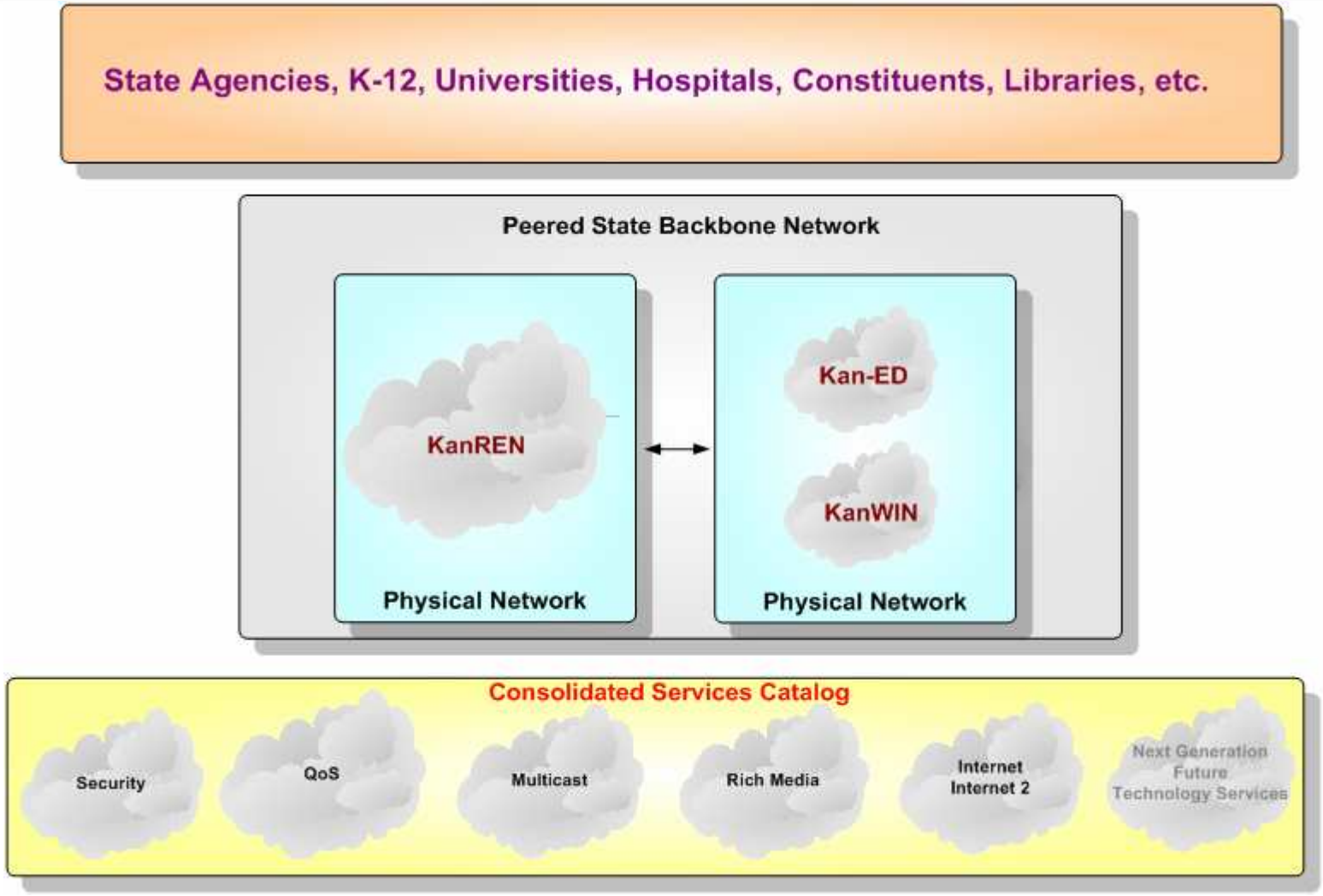
Consolidated Network Model



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Recommendations Matrix

Area	Recommendation
Standardization	➢ Design Standards ➢ Equipment Standards ➢ Kan-ED Carrier Interconnect Standards
Network Consolidation	➢ Kan-ED NAP/Circuit Consolidation ➢ Kan-ED Backbone Migration ➢ State Network Peering Points
Shared Services	➢ Shared Service Model ➢ QoS Design Standardization ➢ Multicast Design Standardization ➢ Rich Media (Video)
Operations	➢ Documentation of Network Data Flows ➢ Realign Kan-ED NOC Services ➢ Telecom Expense Management

Recommendations

- **Design Standards** - Develop consistent network specifications, standards and best practice guidelines for interconnections between the three networks
- **Equipment Standards** - Develop consistent network specifications, standards and proven technology solutions to enable consolidation of network backbones
- **Kan-ED Carrier Interconnect Standards** – Partner with Service Providers to develop clearly defined technical specifications on how they should interconnect to Kan-ED
- **Kan-ED NAP/Circuit Consolidation** - Consolidate Kan-ED backbone NAPs where traffic and service provider peering points are not cost justified

Recommendations

- **Kan-ED Backbone Migration** – Migrate Kan-ED backbone to KDOT dark fiber
  - Short Term: Pilot Kan-ED backbone migration onto the KDOT dark fiber in Kansas City, Topeka and Wichita as "proof of concept" to minimize risk of a large scale migration
  - Long Term: Develop a new design for the Kan-ED optical backbone to interconnect a new ring for the NAPs west of Topeka, e.g. Junction City, Salina and Victoria

- **State Network Peering Points** – Enhance, secure and consolidate existing peering points to facilitate ubiquitous access to the resources available on each individual network

- **Shared Services Model** - Leverage peering points to establish a utility model for shared services across the three networks

- **QoS Design Standardization** – Develop standards and best practice guidelines on QoS policies implemented across the three networks

Recommendations

- **Multicast Design Standardization** – Develop standards and best practice guidelines on Multicast policies implemented across the three networks
- **Rich Media (Video)** – Enhance the enterprise strategy for delivering rich media across the three networks using cost effective, next generation technologies
- **Documentation of Data Flows** – Capture data flows at all critical network touch points to ensure changes do not impact services, applications or other portions of the network
- **Realign Kan-ED NOC Services** - Migrate Kan-ED Network Operations and Support to KanWIN to achieve operational economies
- **Telecom Expense Management** - Audit existing carrier service contracts, billing services and operational processes to achieve savings opportunities

Solutions Roadmap

Project Methodology

Step 1 - Review

Step 2 – Plan

Step 3 – Design

Step 4 – Implement

Step 5 – Support

Phase - 1

- ✓ Design Standards*
- ✓ Equipment Standards
- ✓ Kan-ED Carrier Interconnect Standards
- ✓ Documentation of Network Data Flows
- ✓ Telecom Expense Mgmt

Phase - 2

- ✓ Kan-ED NAP/Circuit Consolidation
- ✓ Kan-ED Backbone Migration**
- ✓ State Network Peering Points
- ✓Realign Kan-ED NOC Services
- ✓ Telecom Expense Mgmt

Phase - 3

- ✓QoS Design Standardization
- ✓ Multicast Design Standardization
- ✓ Rich Media (Video)
- ✓ Shared Services
- ✓ Telecom Expense Mgmt

Phase - 4

- ✓ Future Technology Considerations
- ✓ Shared Services
- ✓ Telecom Expense Mgmt

* Includes KanED and KanREN Network Assessments
** Pilot and Strategy

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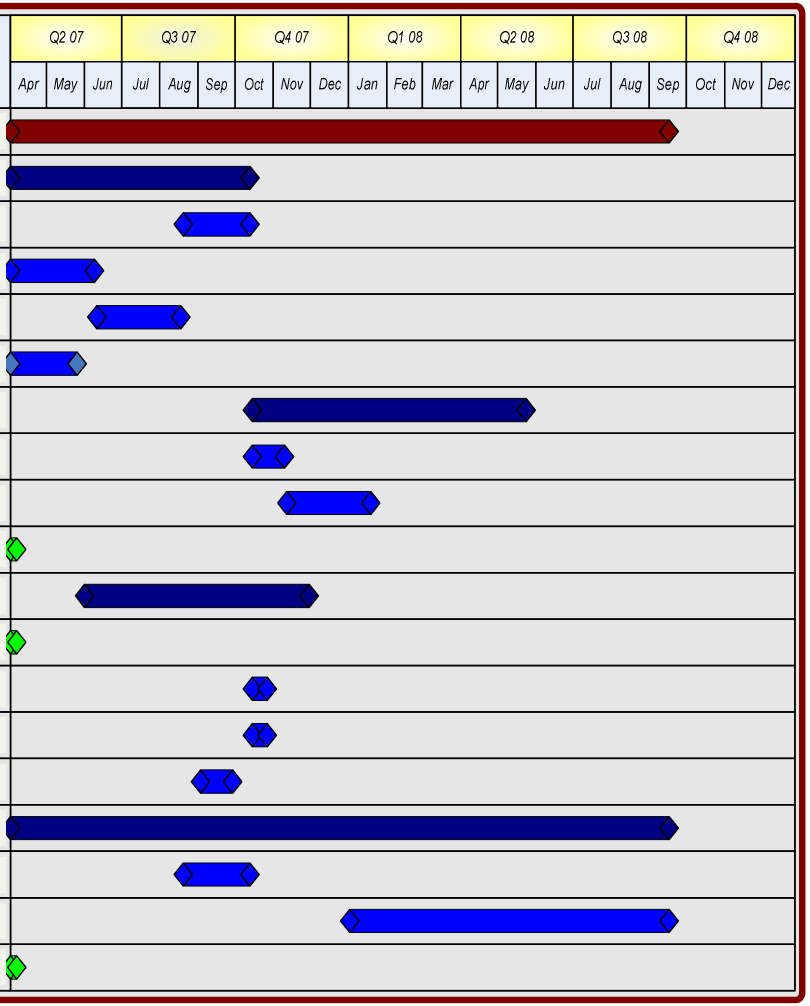
Project Gantt Summary

ID	Project Milestones	Start	Finish	Duration
1	**Kansas State Network Consolidation Project**	4/2/2007	9/16/2008	382d
2	***Standardization***	4/2/2007	10/12/2007	140d
3	Design & Equipment Standards	8/20/2007	10/12/2007	40d
4	KanREN Network Assessment	4/2/2007	6/8/2007	50d
5	KanED Network Assessment	6/11/2007	8/17/2007	50d
6	Kan-ED Carrier Interconnect Standards	4/2/2007	5/25/2007	40d
7	***Network Consolidation***	10/15/2007	5/23/2008	160d
8	Kan-ED NAP/Circuit Consolidation	10/15/2007	11/9/2007	20d
9	Kan-ED Backbone Migration	11/12/2007	1/18/2008	50d
10	State Network Peering Points (Additional scope analysis required)	4/2/2007	4/6/2007	5d
11	***Shared Services***	6/1/2007	11/29/2007	130d
12	Shared Service Model (Additional scope analysis required)	4/2/2007	4/6/2007	5d
13	QoS Design Standardization	10/15/2007	10/26/2007	10d
14	Multicast Design Standardization	10/15/2007	10/26/2007	10d
15	Rich Media (Video)	9/3/2007	9/28/2007	20d
16	***Operations***	4/2/2007	9/16/2008	382d
17	Documentation of Network Data Flows	8/20/2007	10/12/2007	40d
18	Realign Kan-ED NOC Services	1/2/2008	9/16/2008	185d
19	Telecom Expense Management (Additional scope analysis required)	4/2/2007	4/6/2007	5d



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Project Cost Summary

Category	Recommendation	Estimated Cost Saves	Estimated Resource Hours (External)	Estimated Resource Cost (External)	Estimated Capital Cost
Standardization	**Design Standards**	N/A	1120 Hours (Includes Network Assessments)	$200K	None
	Equipment Standards	N/A	- Effort rolled into Network Design Standardization estimate above	- Effort rolled into Network Design Standardization estimate above	None
	Kan-ED Carrier Interconnect Standards	N/A	320 hours	$56K	None
Network Consolidation	**Kan-ED NAP/Circuit Consolidation**	$816K per year	160 hours	$28K	None
	Kan-ED Backbone Migration	TBD - Requires further study	400 hours (pilot and strategy)	$70K	TBD - Requires further study
	State Network Peering Points	N/A	Additional scope analysis required	Additional scope analysis required	Additional scope analysis required
Shared Services	**Shared Service Model**	N/A	Additional scope analysis required	Additional scope analysis required	Additional scope analysis required
	QoS Design Standardization	N/A	80 hours	$14K	None
	Multicast Design Standardization	N/A	80 hours	$14K	None
	Rich Media (Video)	TBD - Requires further study	160 hours (Strategy Only)	$28K	TBD - Requires further study
Operations	**Documentation of Network Data Flows**	N/A	320 hours	$71K	None
	Realign Kan-ED NOC Services	$475K per year	500 hours	- $90K (implementation) - $525K (annual to support KanWIN FTEs)	- $50K (software licenses)
	Telecom Expense Management	TBD - Requires further study	Additional scope analysis required	Additional scope analysis required	- Additional scope analysis required
		$1,291,000	**3140 Hours**	**$571,000 (One Time)** **$525,000 (Recuring)**	**$50,000**

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Approach

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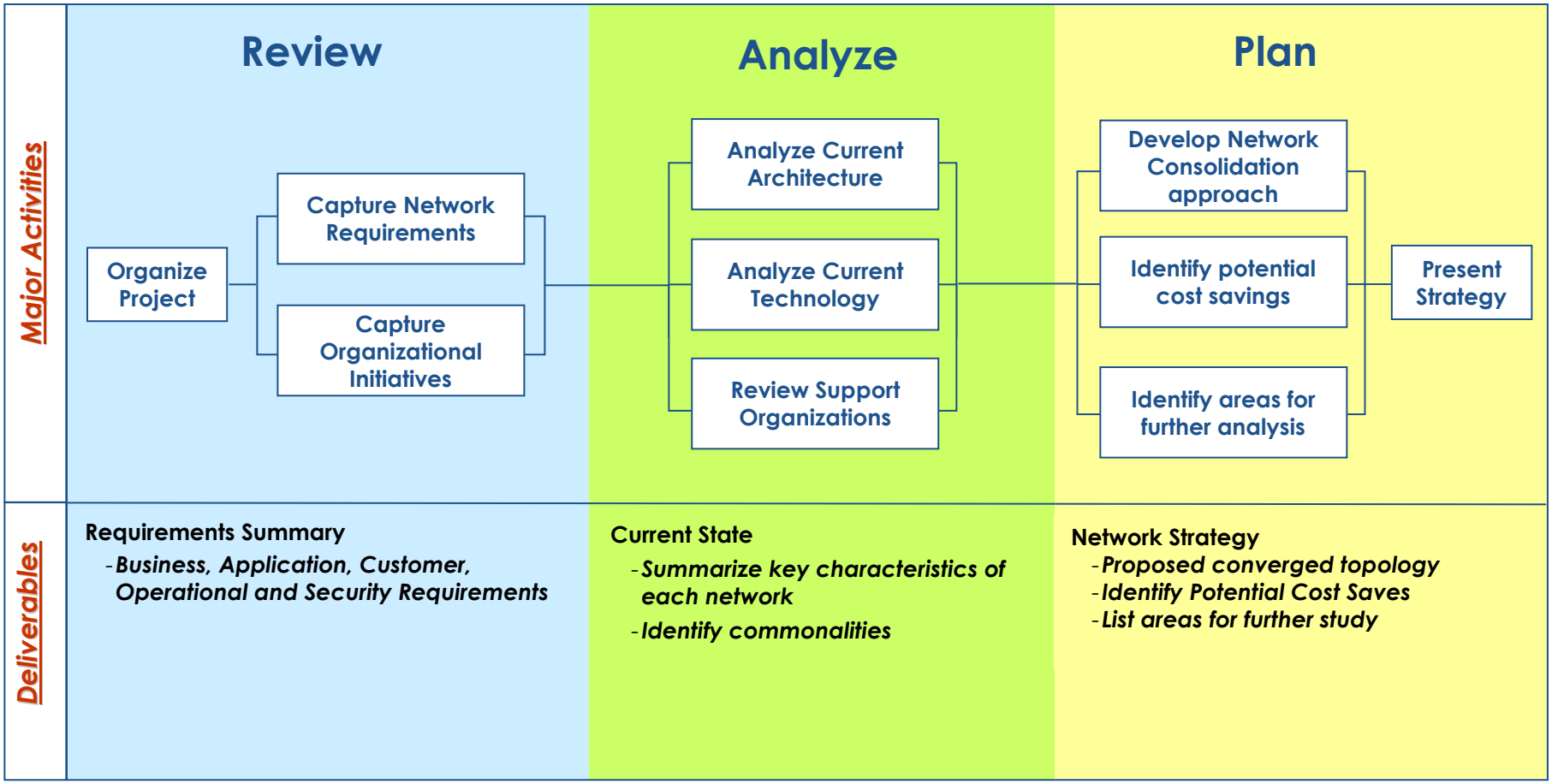
Analysis Methodology



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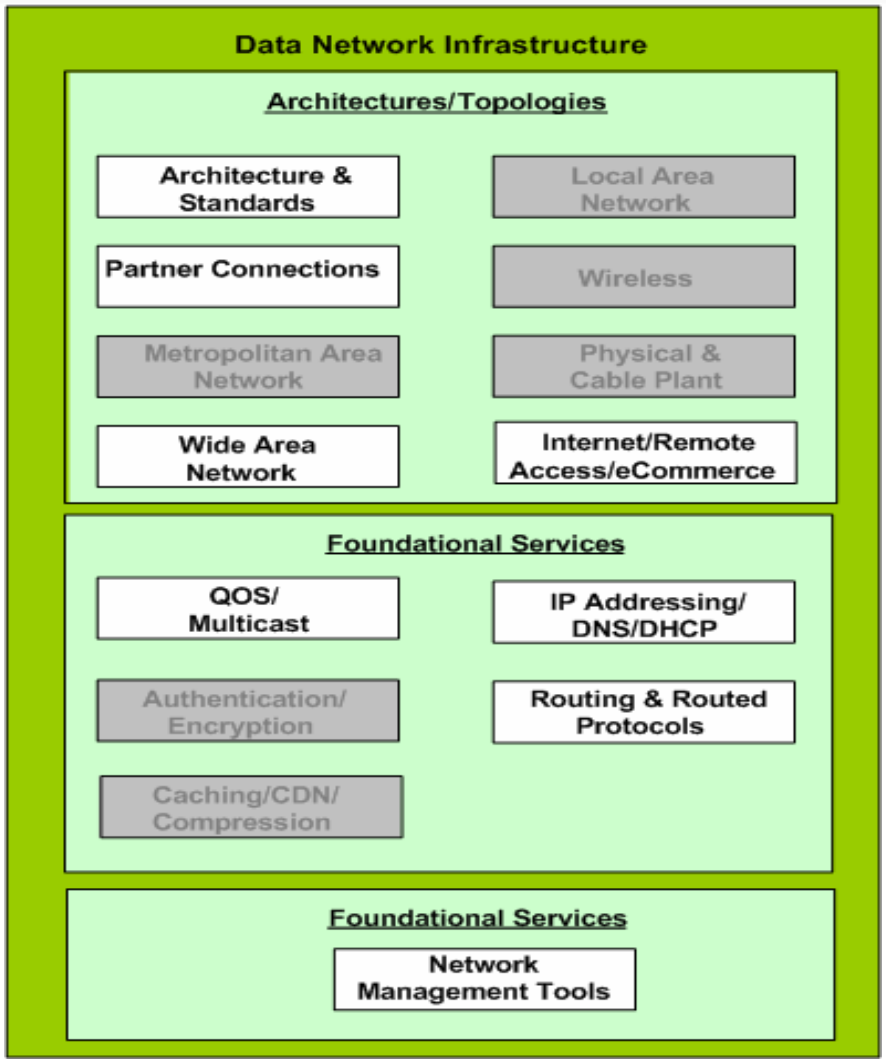
Technology Perspectives

In order, these are the most important areas for the three KAN network teams to focus their time and effort toward strategic "integrated" growth and consolidation

Strategy	Inter-Network Initiatives
Standardize	Develop comprehensive network standards, architecture, and design templates for rich media, data and security. Deploy standard architecture solutions that can be leveraged between each network.
Secure	Establish policies that support the flexible security model of education and the intranet services in addition to the rigorous requirements of the regulatory and state agencies.
Simplify	Adhere to standards and rely on fewer vendors when possible in order to facilitate integration, improve manageability and reduce total cost of ownership (TCO).
Prioritize	Identify mission-critical applications across each network, the underlying infrastructure, document business impact, and establish appropriate redundancy and service levels to support the applications during both intra-network and inter-network delivery.
Structure	Create and adhere to a structured, deterministic network architecture that will simplify design, routing, and troubleshooting within and across each network domain.
Refresh	Update/upgrade and implement technologies that are mature and "proven" next-generation. Maintain a posture to evaluate emerging technologies that will further enable the business and address the inter-network convergence constraints.
Manage	Manage to thresholds, measure performance, compliance, and availability so that it can drive, not limit organizational goals.

Technology Domains



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Current State

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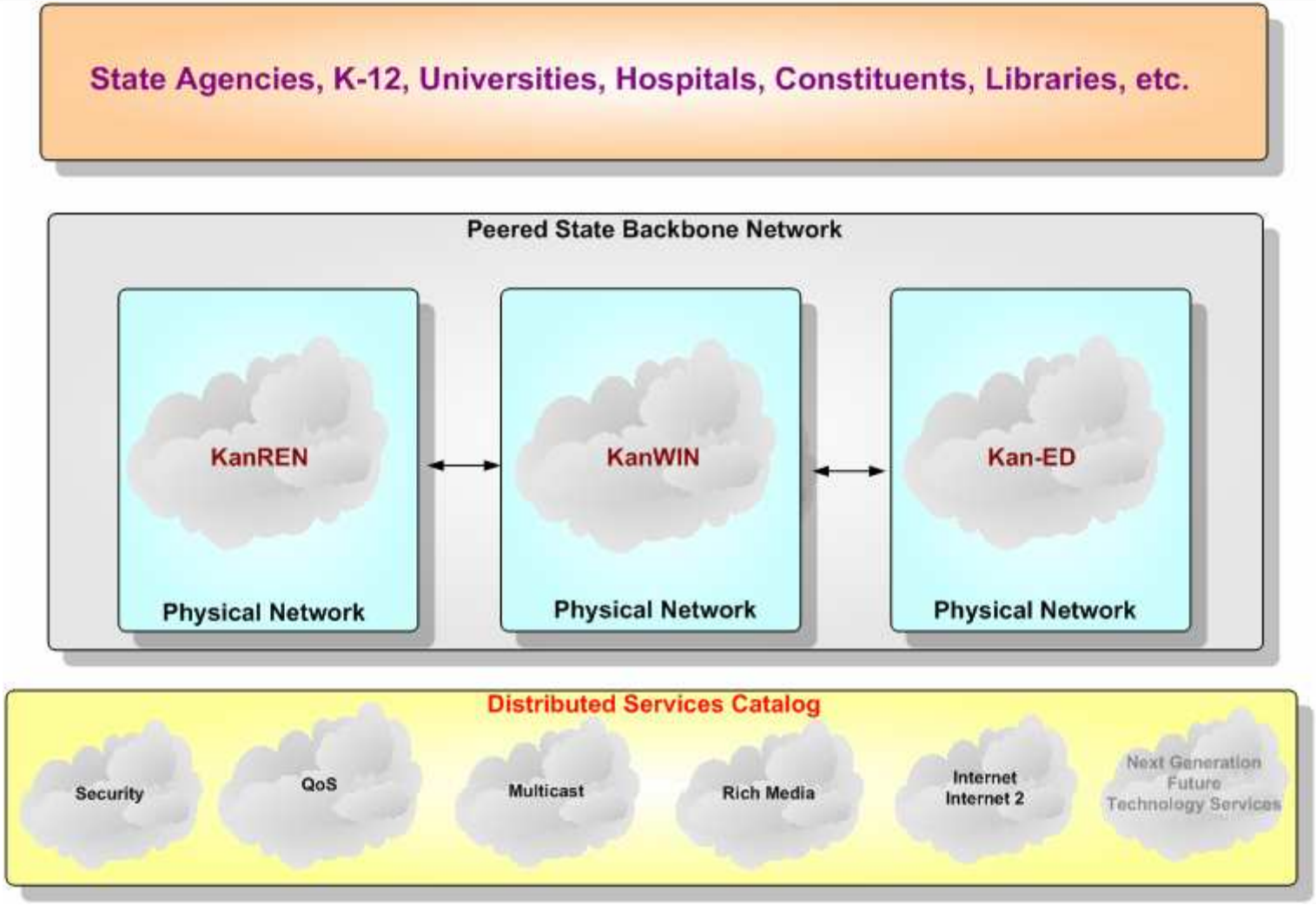
Distributed Network Model



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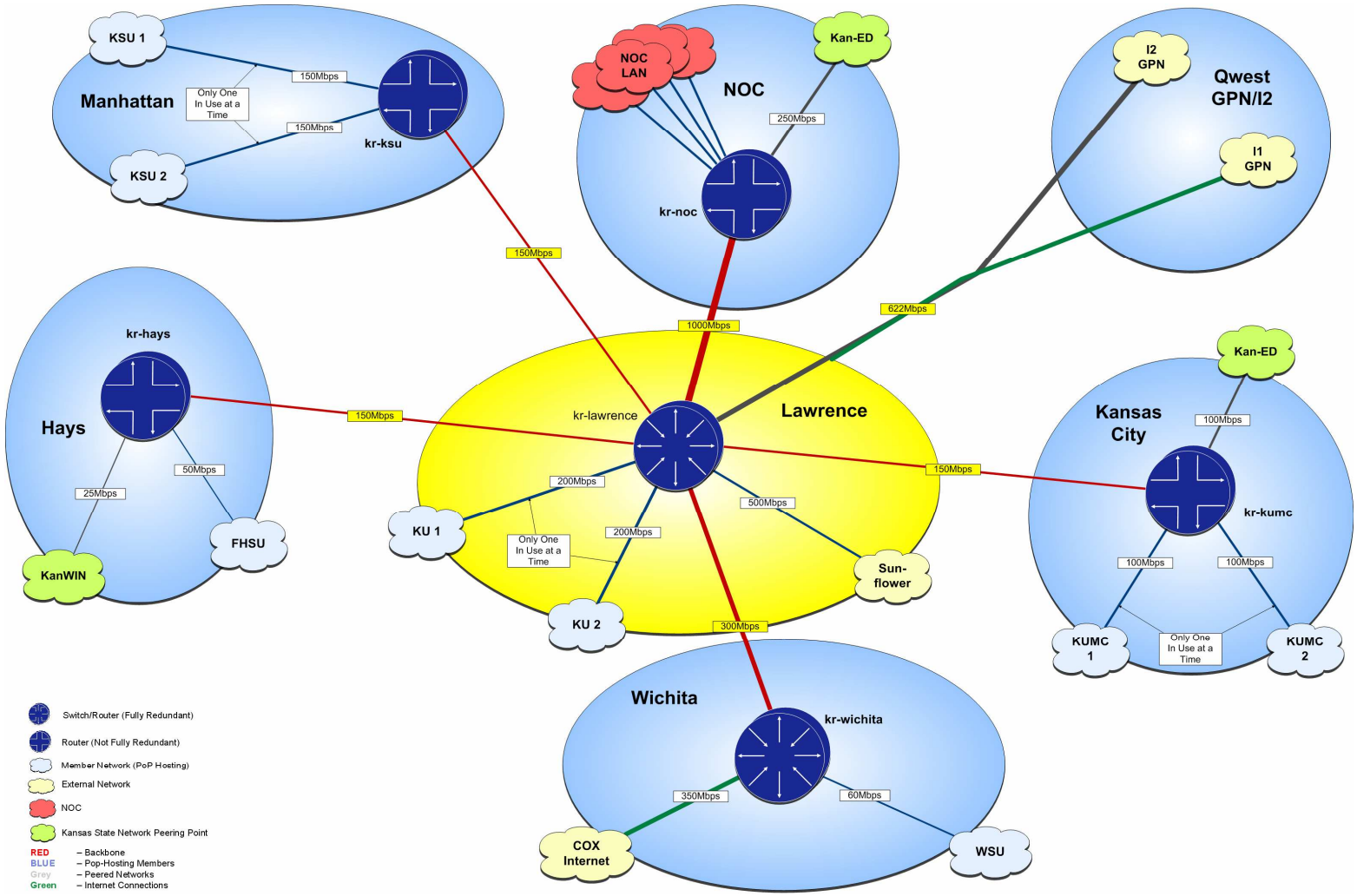
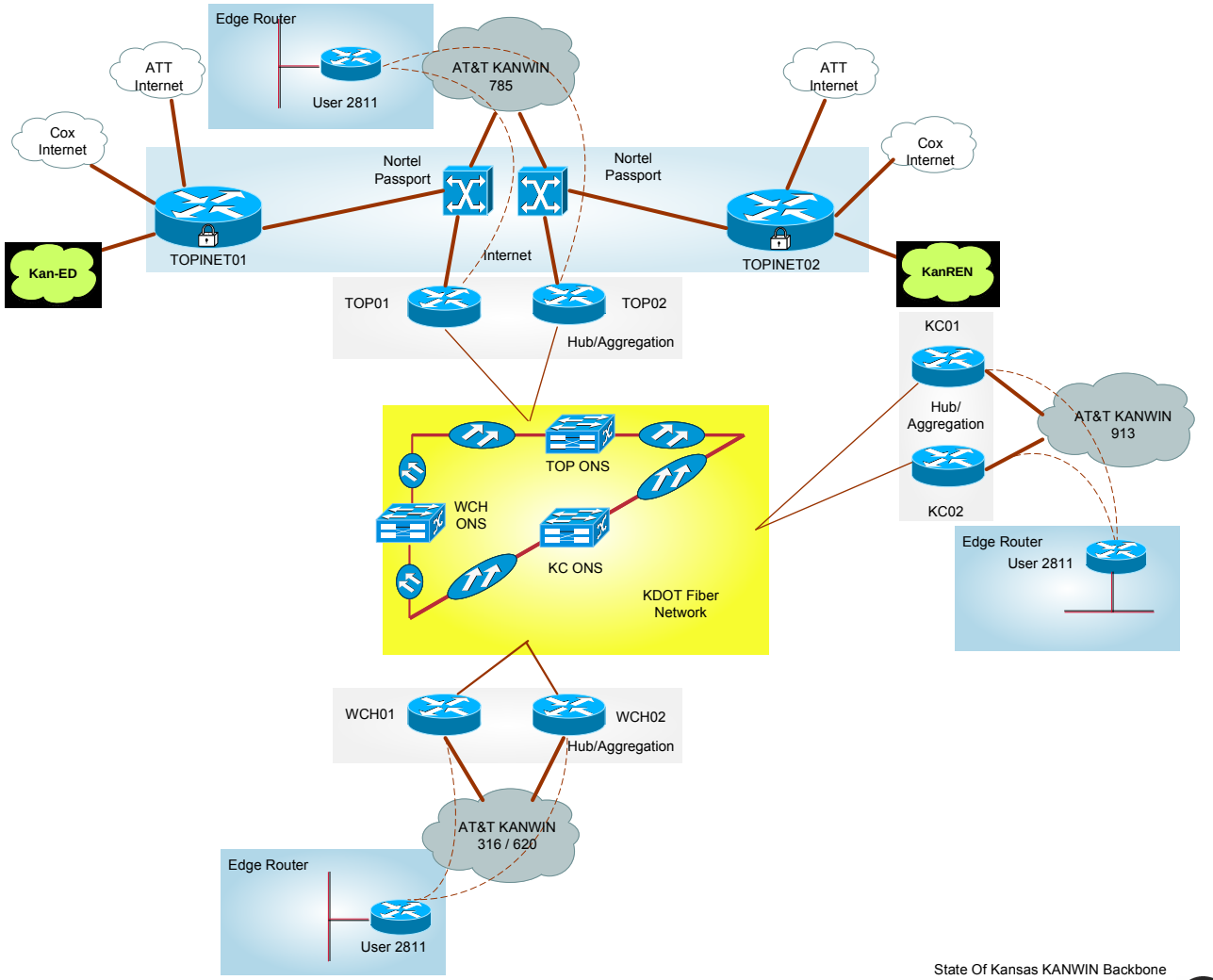
KanREN WAN



KanWIN WAN



State Of Kansas KANWIN Backbone

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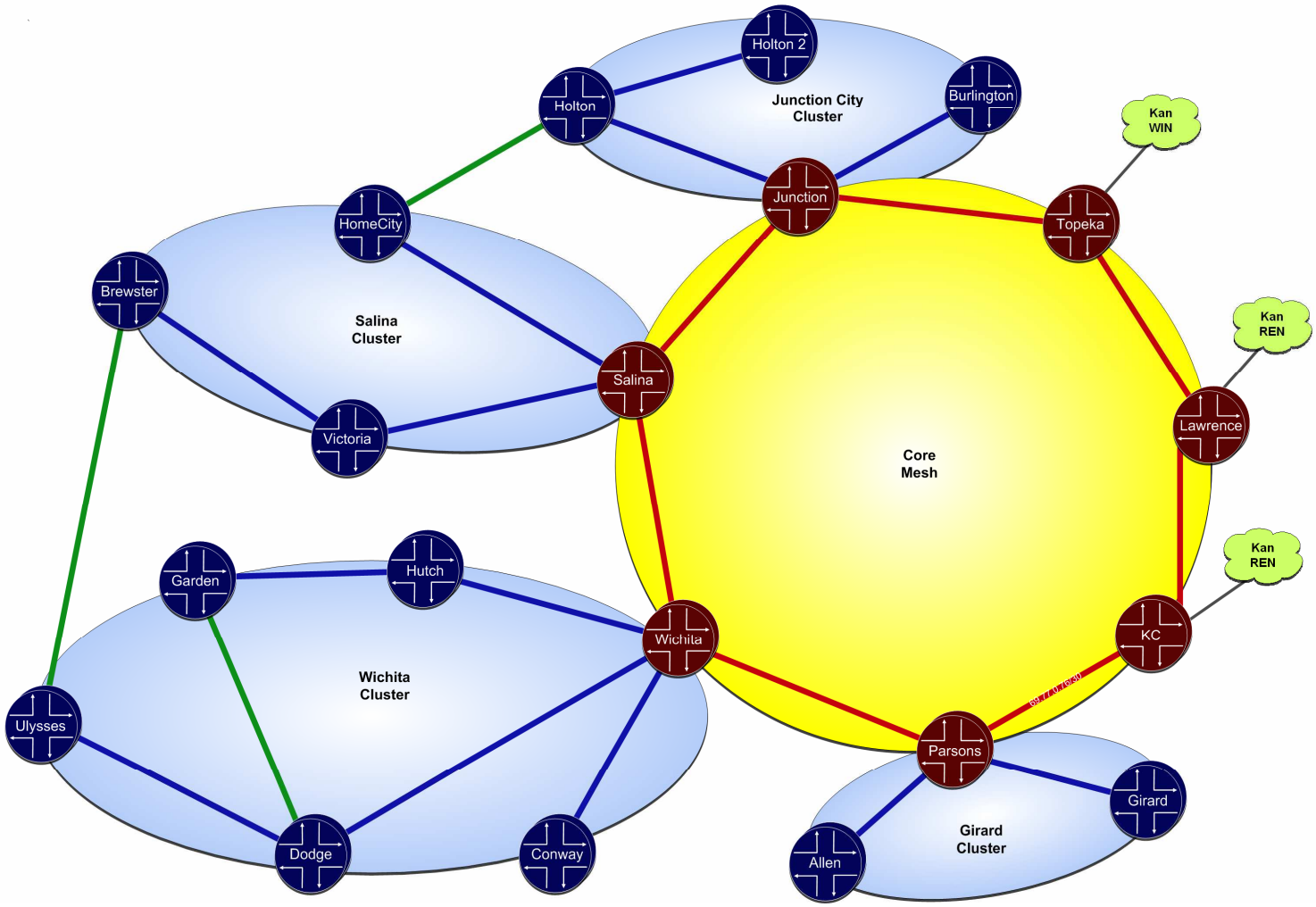
Kan-ED WAN



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Backbone Network Utilization

KanREN

Average Utilization = 25-33%

Peak Utilization = 48-72%

Network Transport = 150-300M

KanWIN

Average Utilization = 2%

Peak Utilization = 16%

Network Transport = 112M

Kan-ED

Average Utilization = 3%

Peak Utilization = 8%

Network Transport = 155M

Monthly Utilization Reports as of Jan-2007

What We Found . . .

- **The three networks have distinguishing intra-network characteristics that preclude comprehensive consolidation**

  Security
  - **KanREN has an inherently open security policy due to its primary mission (research) and services (Internet and Internet2)**
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- **Distinguishing characteristics (continued)**

  Adaptability

  - **KanREN needs the flexibility to be an early technology adopter that is essential to support dynamic research institution requirements**
  - **KanWIN and Kan-ED require a more static environment with predictable growth and business agility**

What We Found . . .

- **Kan-ED Specific Findings**

  Standardization and Complexity

  - Mandated speed of deployment limited ability to define clear Service Provider connection standards
  - Lack of defined connection standards introduced many compromises with how Kan-ED integrated with Service Providers
  - Avoidance of Kan-ED provided Internet services has contributed to additional complexity in Service Provider connections

  Low Backbone Utilization

  - Kan-ED data content is primarily accessed via the Internet
  - Few end users can access Kan-ED due to limited integration between Kan-ED and the member's local area networks
  - Network patterns indicate significant traffic is localized within specific NAPs

What We Found . . .

- **Kan-ED Specific Findings**

  Video Overlay Network

  - **Many Kan-ED connections terminate directly into video equipment**
  - **Video classrooms are not architecturally efficient**
    - **4 Video Endpoints**
    - **4 Monitors**
    - **Multiple network connections required**
    - **Video endpoints are configured with a bit-rate of 768K (384K meets the industry standard for business quality)**
    - **Next-generation technologies are not leveraged to achieve operational economies or enhanced performance opportunities such as:**
      - » **H.264 video compression enables video conferencing users to experience either significantly improved video quality at the same bit rate, or current quality at approximately half the bit rate required previously (e.g. 768K video quality with a H.264 configuration that only requires 384K)**
    - **High cost maintenance model**

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Recommendations

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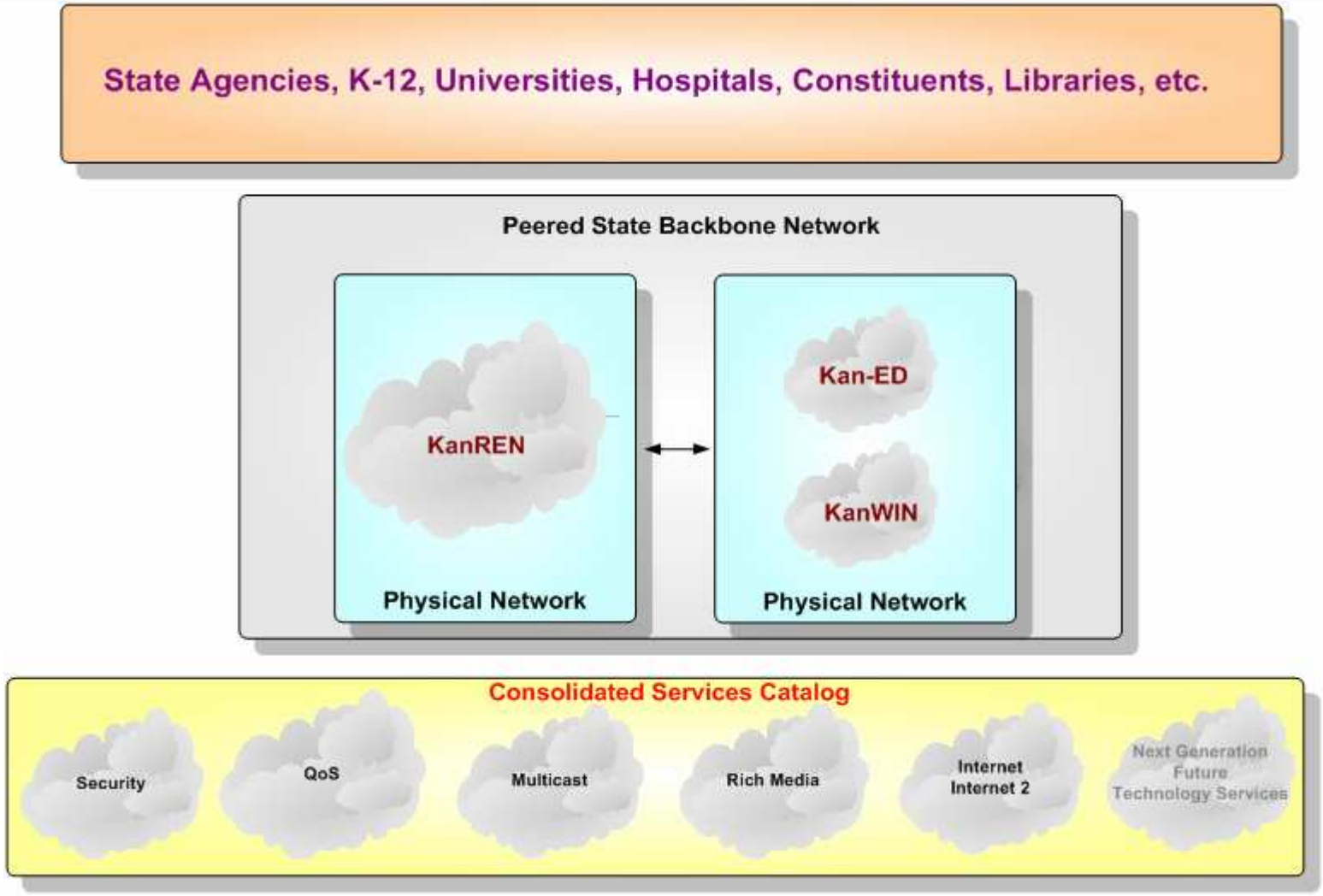
Consolidated Network Model



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Recommendations Matrix

Area	Recommendation
Standardization	➢ Design Standards ➢ Equipment Standards ➢ Kan-ED Carrier Interconnect Standards
Network Consolidation	➢ Kan-ED NAP/Circuit Consolidation ➢ Kan-ED Backbone Migration ➢ State Network Peering Points
Shared Services	➢ Shared Service Model ➢ QoS Design Standardization ➢ Multicast Design Standardization ➢ Rich Media (Video)
Operations	➢ Documentation of Network Data Flows ➢ Realign Kan-ED NOC Services ➢ Telecom Expense Management

Standardization

- **Design Standards**
  - Develop consistent standards to define how state networks should be interconnected
    - Network and Security architecture for peering points
    - QoS service mapping of traffic as it ingresses/egresses from one state network to another
    - Multicast architecture and design
    - Video architecture and design
- **Equipment Standards**
  - Develop WAN equipment standards in preparation for KanWIN/Kan-ED backbone consolidation
    - Increases interoperability and support for services such as QoS and MPLS
    - Reduce operational costs (TCO) by minimizing the number of vendor platforms supported
    - Training/Support cost reduction

Standardization

- **Kan-ED Carrier Interconnect Standards**
  - **Define clear technical specification with partnering Service Providers to define how to interconnect with the Kan-ED network**
    - **Design goal should address simplification of routing and robustness of the network architecture**
    - **Focus on tighter integration with member LANs to enable access to current and future Kan-ED data services**
    - **Address end-to-end support for QoS and Multicast**

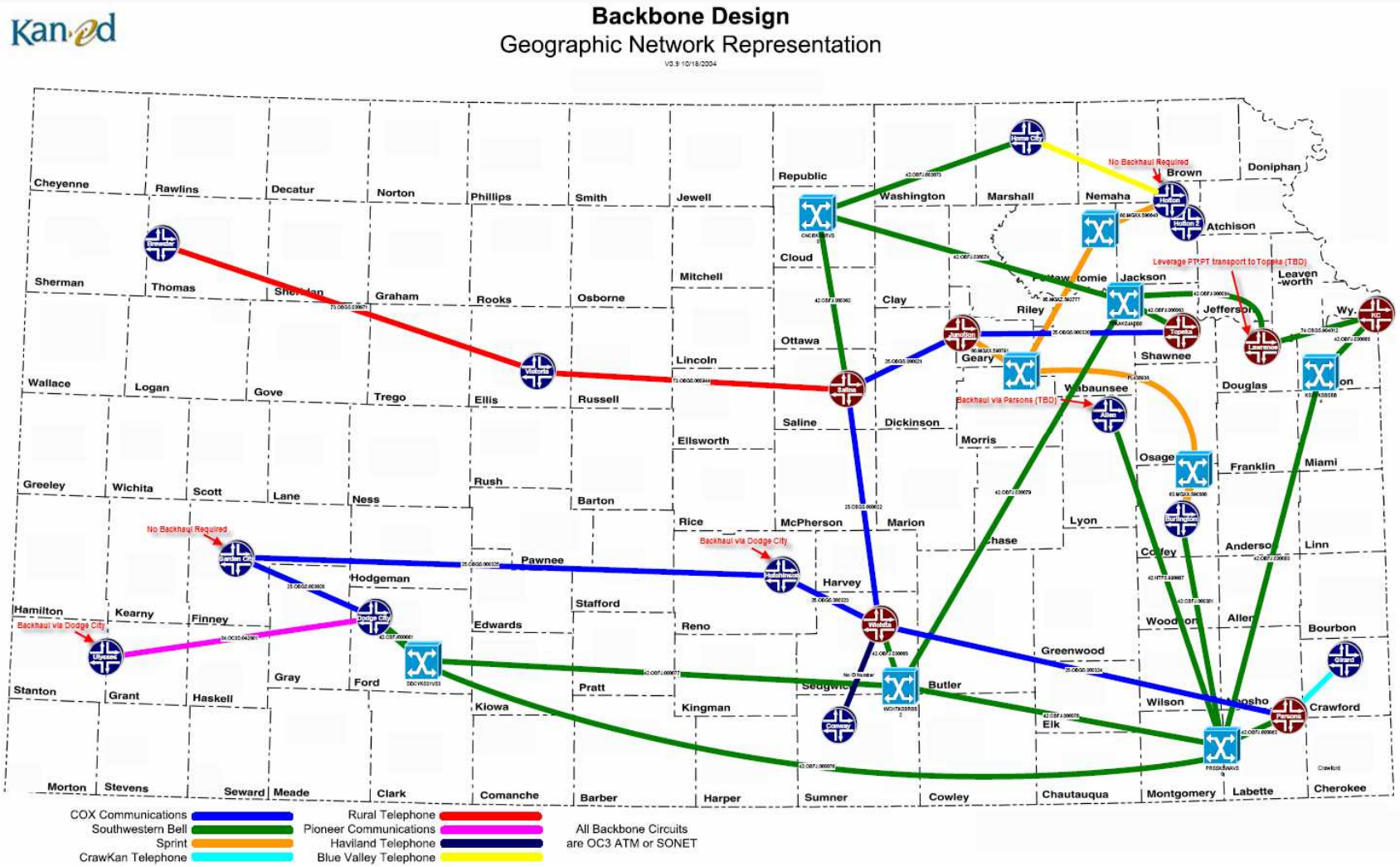
Network Consolidation

- **Kan-ED NAP/Circuit Consolidation**
  - Consolidate NAPs that are either under utilized or not cost effective
    - Policy for NAP - Two providers connecting to a minimum of two constituents
    - Candidates for consolidation: Garden City, Hutchinson, Holton and Allen are candidate locations for NAP consolidation
    - Cost Save Opportunity – DS3 circuits and Juniper M7i routers ($40K ea.) with OC3 4-port cards supporting the NAP
  - Eliminate nonessential circuits between Kan-ED NAPs

Network Consolidation

- **Kan-ED NAP/Circuit Consolidation**
  - Consolidation Strategy
    - Ulysses – backhaul via Dodge City
    - Hutchinson – backhaul via Dodge City
    - Garden City – eliminate w/o additional backhaul
    - Holton – eliminate w/o additional backhaul
    - Lawrence (TBD) – leverage Topeka- Kansas City transport
    - Allen (TBD) – backhaul via Parsons
    - Additional consolidation opportunities (TBD)

Kan-ED NAP Consolidation



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Network Consolidation

- **Kan-ED Backbone Migration**
  - **Short Term**
    - **Pilot Kan-ED fiber backbone in Kansas City, Wichita and Topeka NAPs as a "proof of concept" to minimize risk of a large scale migration**
    - **Leverages KDOT Fiber Backbone and Cisco ONS Infrastructure**
    - **Cost savings opportunities will not be realized until backbone can be re-architected to leverage larger scale deployment**
  - **Long Term**
    - **Develop a new design for the Kan-ED optical backbone to interconnect a new ring for the NAPs west of Topeka, e.g. Junction City, Salina and Victoria**
    - **Partner with Service Providers to provide OC-3 circuits throughout the south west and south central portions of the state to maintain a protected path**

Network Consolidation

- **State Network Peering Points**
  - Enhance, secure and consolidate existing peering points between the three networks
    - Allows services of all three networks to be shared in a secure and optimized manner
    - Share physical network infrastructure while interconnecting logically separated networks
    - Leverage cost effective Kan-ED Extended Edge NAPs to connect rural KanWIN agencies and backhaul traffic to peering points
    - KanWIN as a potential Service Provider for Kan-ED members that have no cost effective alternatives
    - KanWIN as a complementary Service Provider for KanREN members that have network requirements to transport mission critical applications and data

Shared Services

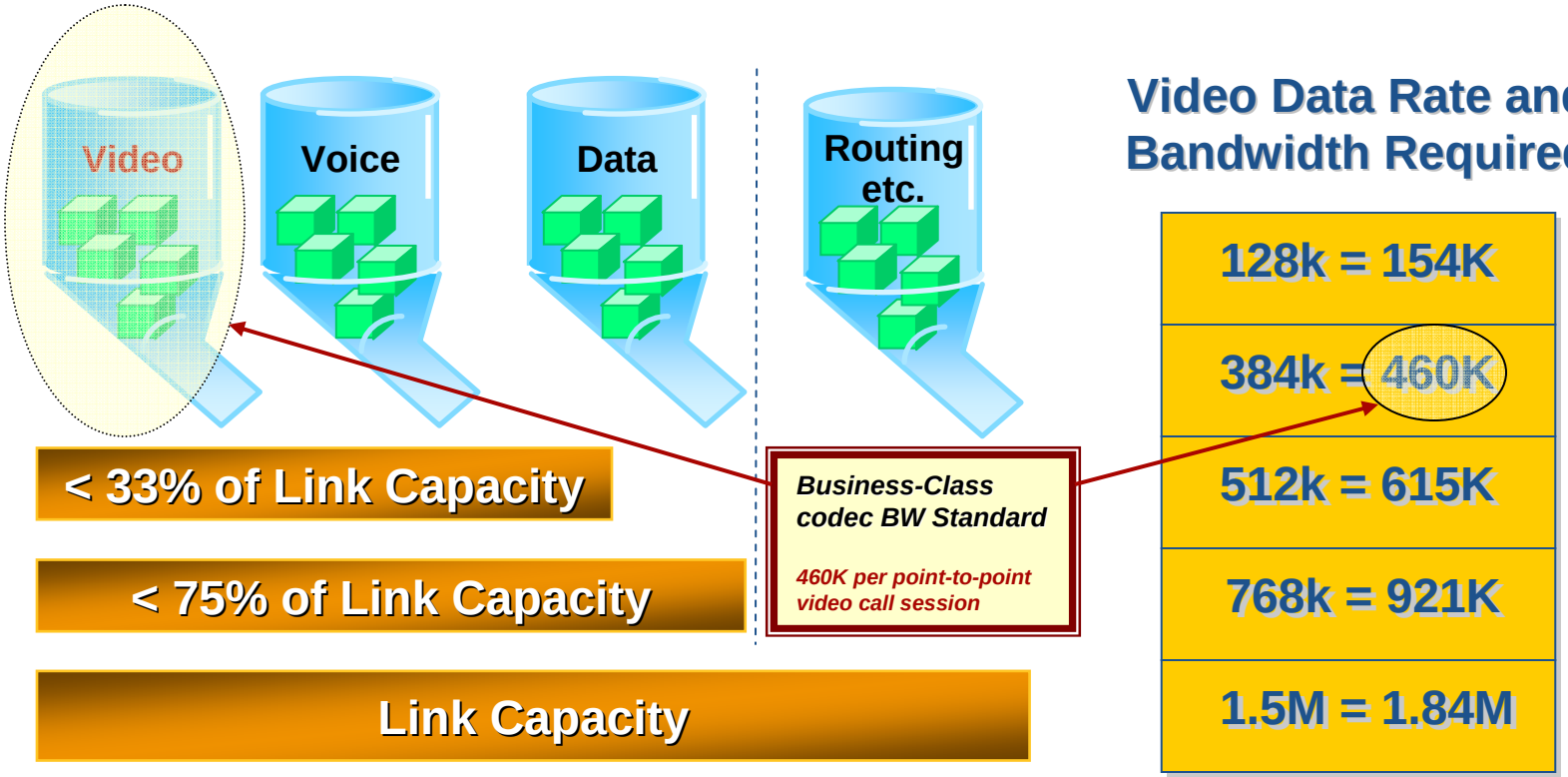
- **Shared Service Model**
  - Leverage peering points to establish a utility model for shared services across the three networks
    - Provide a foundation for supporting future shared and co-located services between the three networks
    - Define a support model, operational processes and tools required to share services
    - Define the investment and cost allocation model for funding shared services

Shared Services

- QoS Design Guidelines
  - Video traffic should not exceed 33% of the WAN network capacity
  - All network traffic should not exceed 75% of the WAN network capacity
  - QoS policies and traffic management must factor in the 20% overhead over the video codec's BW setting in the overall determination and management of video traffic
  - QoS classes should be defined for Real-time (voice & data), Call Signaling, Critical Data and "Best Effort"

QoS Design Guidelines

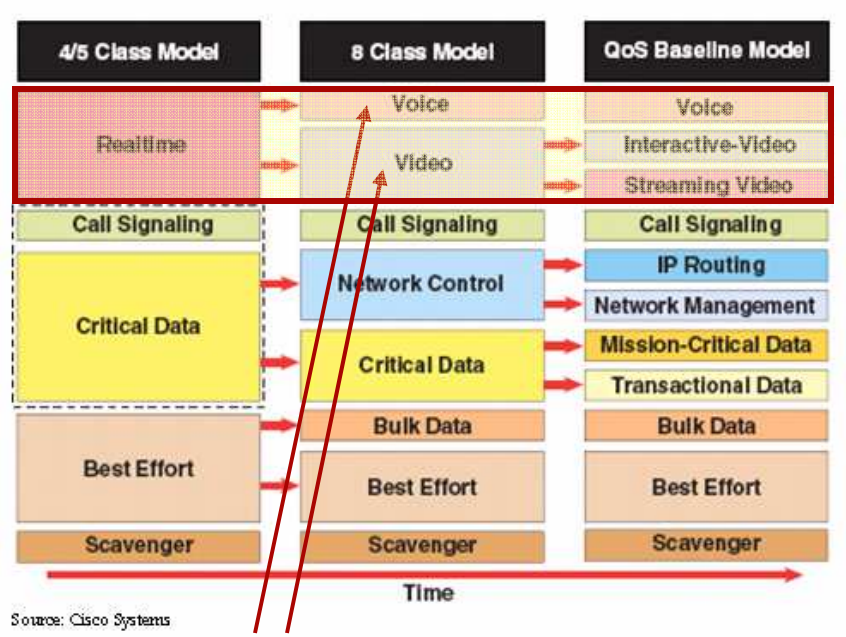
Video Data Rate + 20% = Bandwidth Required

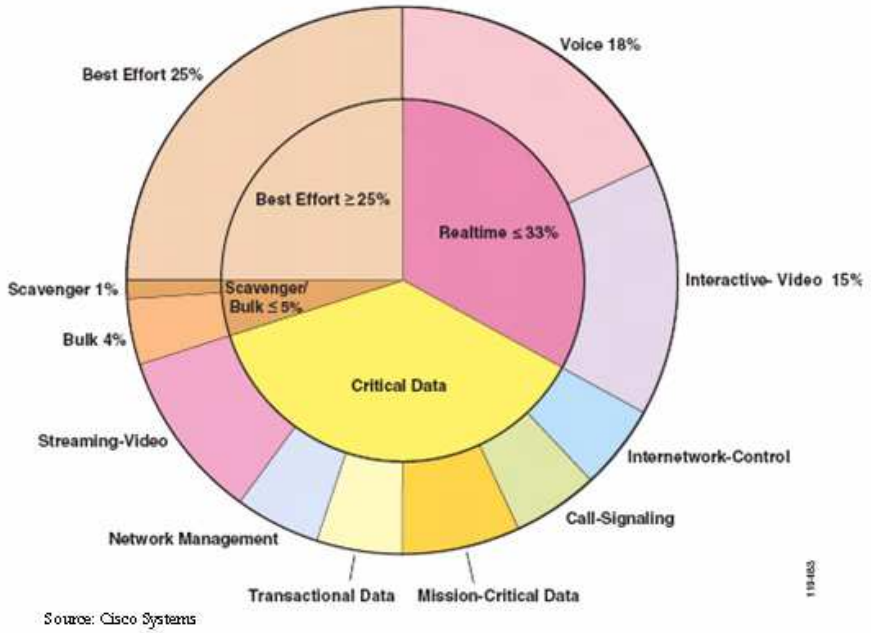


Media traffic + 10% IP overhead + 5% - 10% additional overhead if using IP encapsulation in the WAN such as Frame Relay or ATM

Source: Cisco Systems

QoS Design Guidelines





Combine Voice & Video into the Real-time QoS Class Model

	QoS Markings		
Classification	DSCP	PHB	CoS
IP Voice	46	EF	5
IP Video	34, 36, 38	AF 41-43	4
Certified	26, 28, 30	AF 31-33	3
Express	16, 18, 20	AF 21-23	2
Business	8, 10, 12	AF 11-13	1
Standard	0	0	0

QoS/Traffic Shaping Guidelines

Shaping vs. Policing

- Shaping well suited for Frame Relay and ATM networks
- Policing will drop and/or mark down packets
- Strict traffic policing does not discriminate between flows

Recommendations:

- Traffic shaping should be used for Frame Relay and ATM
- Modify burst size (Bc) to reduce Tc to 10ms
- Change CIR to 95%

	Profile/QoS Requirements				
Classification	**Packet Size**	**Bandwidth**	**Delay**	**Jitter**	**Loss**
IP Voice	Small	Low	Low	Low	Low
IP Video	Variable	High	Low	Low	Low
Certified	Small	Low	Low	Moderate	Low
Express	Small	Low	Low	High	Low
Business	Variable	Moderate	Moderate	High	Moderate
Standard	Large	High	High	High	High

Recommendation: Focus on the technical profile of the traffic flow (e.g. protocol, packet size, bandwidth requirements) as well as its ability to deal with the effects of congestion (e.g. delay, jitter and packet loss).

WRED Vs. FRED		
Feature	**WRED**	**FRED**
Can be used with CBWFQ policy maps	Yes	No
Prevents tail drop and global synchronization	Yes	Yes
Prevents TCP starvation	No	Yes
Allows per-class configuration	Yes	No

Weighted RED (WRED) tends to protect small flows from large flows in the same class

Recommendations:

- Use WRED on a class-by-class basis where appropriate
- WRED should not be applied to the voice queue (LLQ)

Traffic flows can be identified by the following fields:

- ✓ Source IP address
- ✓ Destination IP address
- ✓ Transport layer protocol (TCP or UDP)
- ✓ TCP or UDP source port
- ✓ TCP or UDP destination port

Recommendation: Traffic flows should be identified by the transport layer protocol and the source/destination port whenever possible. As a backup, use the source and/or destination IP address.

	QoS Markings		
Classification	**DSCP**	**PHB**	**CoS**
IP Voice	46	EF	5
IP Video	34, 36, 38	AF 41-43	4
Certified	26, 28, 30	AF 31-33	3
Express	16, 18, 20	AF 21-23	2
Business	8, 10, 12	AF 11-13	1
Standard	0	0	0

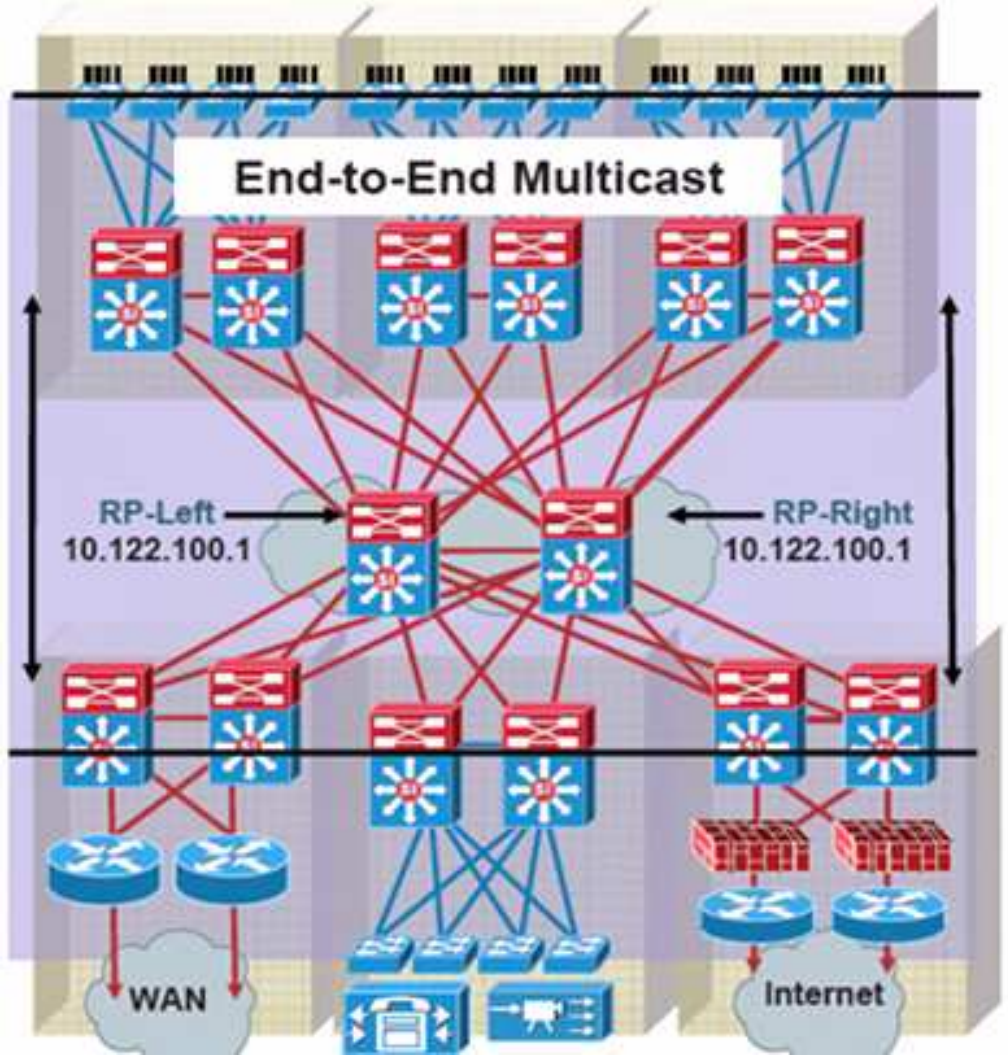
Recommendations:

- Traffic flows should be classified and marked as close to the source as technically and operationally feasible
- The middle range of the DSCP value should be used within each traffic class for the initial QoS configurations scripts

Shared Services

- **Multicast Design Guidelines**
  - Use IGMP Snooping capable hardware in the Access tier
  - Use PIM Sparse-Mode for the multicast protocol
  - Enable PIM on ALL device interfaces
  - Enable PIM Sparse-Mode on routing nodes (Core, Distribution and Access) tiers, where applicable
  - Use Anycast RP & MSDP for RP high-availability redundancy and optimum convergence

Multicast Design Guidelines



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Shared Services

- **Rich Media (Video)**
  - Rich Media management infrastructure should be deployed in a shared utility model at regional network touch points for MCUs, Gateways and Gatekeepers
  - H.264 technology can increase the video quality and reduce the network BW requirements
  - Legacy video codes should be upgraded or replaced to leverage the next generation feature sets and technical efficiencies
  - The distributed video endpoint model (4 per room) is not technically efficient or economically prudent
  - A state-wide video strategy should be executed to achieve the appropriate economies and technical benefits

Rich Media (Video)

Area	Recommendation
High Availability & Security	➢ Deploy a regional admission control solution (gatekeepers) to enhance the security posture of the video infrastructure ➢ Deploy regional MCU appliances, which scale very effectively while providing regional MCU backup support
Stability & Performance	➢ Update Real-time QoS policy and append the "interesting traffic" criteria for the IP enabled video endpoints and enterprise infrastructure components (e.g. gatekeepers, MCU, gateways, etc.) ➢ Ensure all video endpoints support H.264 technology, which reduces the codec BW requirement by half and doubles the video codec quality (results in lower WAN BW requirements and circuit cost)
Standardization	➢ Configure regional IP addresses for each video endpoint that supports IP, while retaining ISDN (if applicable) for backup capability or the primary transport, when IP is not available or feasible ➢ QoS (DSCP and PHB) markings should be configured using per recommended guidelines and vendor IP service ports identified in the Video IP Services & Ports table
Management	➢ Deploy a video management and scheduling solution, e.g. (Tandberg TMS that provides multi-vendor support) ➢ Integrate email (e.g. Outlook client) with video management and a compatible scheduling solution

Rich Media (Video)

Video IP Ports and Services Table

Protocol	Service & Port(s)	Description
H.323	UDP 2326-2373, 3837	Conference communications (Tandberg)
H.323	TCP 5555 -5599	Conference communications (Tandberg)
RTP	UDP 971 – 973	Streaming video (Tandberg)
N/A	TCP 1027	VNC Remote Control (Tandberg)
FTP	TCP 1026	FTP Access (Tandberg)
N/A	TCP 963	Netlog (Tandberg)
H.323	TCP 3230 - 3235	Conference communications (Polycom)
H.323	UDP 3230 - 3247	Conference communications (Polycom)
H.323	TCP 3603	Web interface control per endpoint (Polycom)
H.323	TCP 1503	T.120 collaboration
H.225.0 RAS	TCP 1719	Registration and call admission per gatekeeper
H.225.0	TCP 1720	Q.931 call signaling
H.245	TCP *Dynamic*	Call control channel
H.235	UDP *Dynamic*	Security and encryption for H-series (H.323 and other H.245-based) multimedia terminals
RTP	UDP *Dynamic*	Rich media streaming

Operations

- **Documentation of Network Data Flows**
  - **Data Flows should be captured at all critical network touch points**
    - **Ensure changes do not impact existing services, applications and other portions of the network infrastructure**
    - **Proactively plan for network and configuration changes**
    - **Avoid problems and reduce troubleshooting time during changes**
    - **Ensure that traffic is routing correctly after changes**

Operations

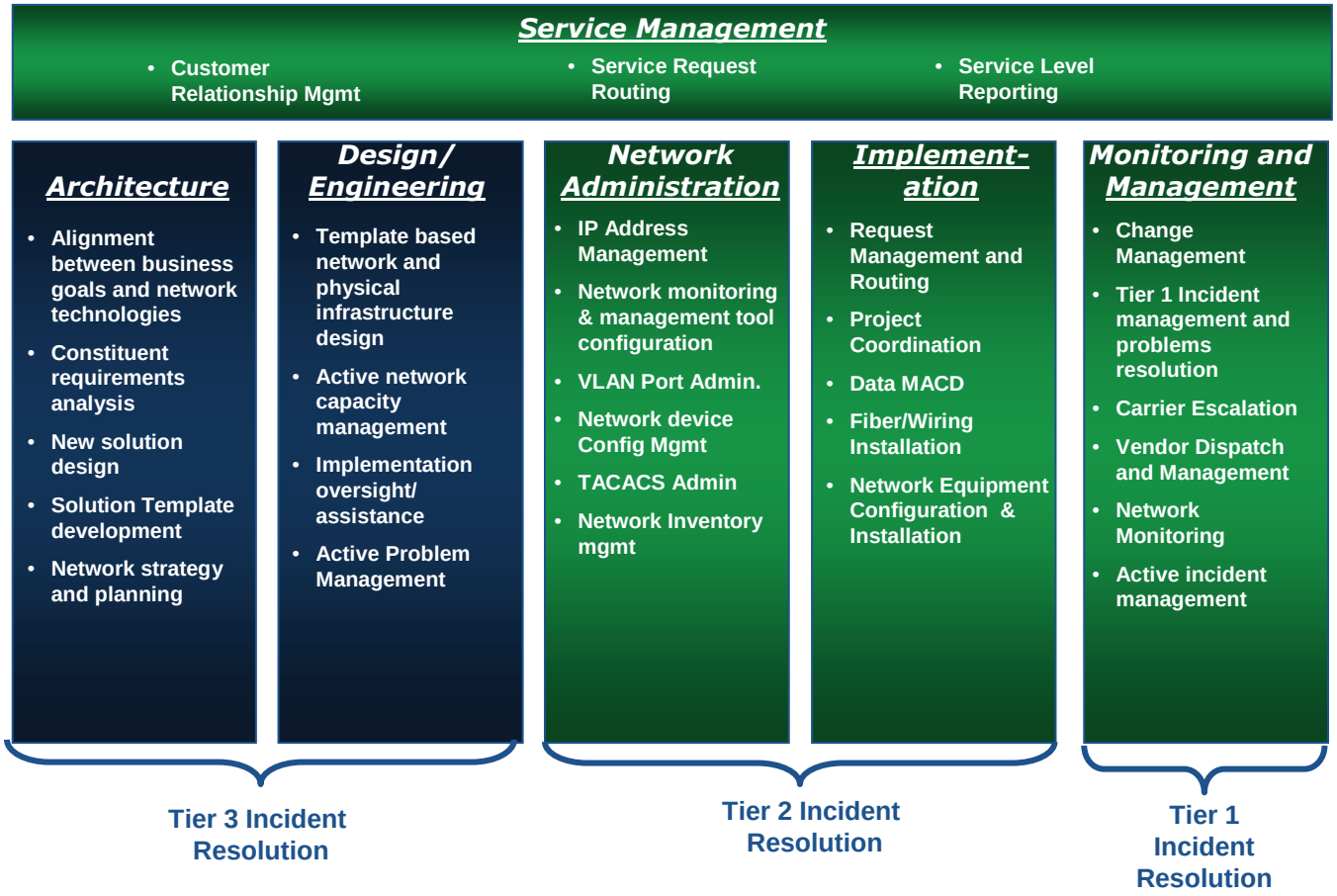
Network Data Flow Template

Initiating Server (or subnet)				Responding Server (or subnet)		
Host/Subnet IP Address	**Initiating Application Name & Description**	**Protocol And Port**	**Description of the data flow.**	**Host / Subnet IP Address**	**Responding Application Name & Description**	**Protocol and Port**
——— Example ———						
Any IP address	Any web browser anywhere on Internet	HTTP (TCP 80)	Customers visiting the corporate web page	1.1.1.1	Apache web server residing on device AzWebServer01	any > 1023
1.1.1.1	Apache web server residing on device AzWebServer01	TCP 4444	Front end web server retrieving customer records from application server	2.2.2.2	Application server residing on device AppServer01	any > 1023
——— Your Data Flows ———						

Operations

- **Realign Kan-ED NOC Support Services**
  - Assess KanWIN NOC capabilities against Kan-ED support Requirements
    - Tier One Service Desk (i.e., first line of support for customers)
    - Network monitoring and event handling
    - Network utilization reporting
    - Provisioning of new Kan-ED member sites
    - Video support
  - Position KanREN NOC to provide Tier Two Support for a transitional period
  - Issue RFP for Kan-ED Network Support if KanWIN support capabilities cannot meet Kan-ED operational requirements

Operations



- This is not intended to be an organizational chart or structure. The diagram illustrates a potential interim overlay of tier 1-3 responsibilities between KanWIN and KanREN.
- The green zone represents the functions to be performed by KanWIN.
- The blue zone represents the interim functions to be performed by KanREN

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Operations

- **Telecom Expense Management**
  - **What is it** - provides a technology foundation that allows organizations to minimize their voice, data, and wireless telecommunications expenses while optimizing the management of their telecommunications
  - **What does it do** - Provides a comprehensive solution for managing the physical processing of invoices, reporting, circuit management, provisioning, procurement and SLAs
  - **Why do it** - Telecom Expense's are in the top five highest expenses an organization deals with today, with 20-30% of that expense being labor
  - **Business Drivers** - new converged networks, new carrier rate increases, industry consolidation and integration of different billing platforms
  - **Benefits**
    - Gain control of one of your largest expenses
    - Visibility into telecom spend
    - Cost Reduction
    - Accurate Allocation and Chargeback
    - Historical billing error recovery

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Next Steps

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Next Steps - Project Initiatives

Category: Standardization

Description:
- Develop consistent network specifications, standards and best practice guidelines for interconnections between the three networks

Cost Save Opportunity:
- Enabler for Network Consolidation recommendations and corresponding cost saves

Recommendation: Design Standards

Project Cost Breakdown:

Estimated Total Resource Hours:	1120
Estimated Resource Cost:	$200,000
Estimated Capital Cost:	$0

Assumptions:
- Standards will be limited to points that could impact integration (such as IP addressing and security policies)
- Enables network integration work
- Implementation of standards performed by internal support staff

Constraints for Implementation:
- Balancing requirements of each network against consistent standards
- Lack of detailed assessments of the Kan-ED and KanREN WAN environments

Next Steps:
- Implement Technology Advisory Council with representation from each network
- Establish Parameters of Design Standards to be defined
- Develop Detailed Network Assessments of Kan-ED and KanREN WANs (similar to KanWIN study)
- Develop Network Design Standards
- Implement Network Design Standards

Next Steps - Project Initiatives

Category: Standardization

Description:
- Develop consistent network specifications, standards and proven technology solutions to enable consolidation of network backbones

Cost Save Opportunity:
- Decreases Total Cost of Ownership by lowering support and training costs

Recommendation: Equipment Standards

Project Cost Breakdown:

Estimated Total Resource Hours:	Rolled into Design Standard
Estimated Resource Cost:	Rolled into Design Standard
Estimated Capital Cost:	$0

Assumptions:
- Scope of standards will be limited to vendor and recommended OS versions
- Enables network integration work
- Implementation of standards performed by internal support staff

Constraints for Implementation:
- Termination penalties could be applicable for existing hardware and maintenance contract(s)
- Support staff skill sets to support selected platforms

Next Steps:
- Equipment standard defined by Technology Advisory Council
- Replacement of non-standard equipment

Next Steps - Project Initiatives

Category: Standardization

Description:
- Partner with Service Providers to develop clearly defined technical specifications on how they should interconnect with Kan-ED

Cost Save Opportunity:
- Reduces network complexity to enable additional services without additional infrastructure investment
- Decreases Total Cost of Ownership by lowering support costs

Recommendation: Kan-ED Carrier Interconnect Standards

Project Cost Breakdown:

Estimated Total Resource Hours:	160 ~ 320
Estimated Resource Cost:	$28,000 to $56,000
Estimated Capital Cost:	$0

Assumptions:
- Will require Service Provider participation for success
- Implementation of standards performed by internal support staff

Constraints for Implementation:
- Service Providers have different technology platforms and separate business objectives that could inhibit consensus on interconnection policy standards

Next Steps:
- Identify representative Service Providers for participating in study
- Develop Interconnection Policy Standards
- Implement Interconnection Policy Standards

Next Steps - Project Initiatives

Category: **Network Consolidation**

Description:
- Consolidate Kan-ED backbone NAPs where traffic and service provider peering points are not cost justified

Cost Save Opportunity:
- Elimination of surplus circuits provides an estimated monthly cost save of $32K
- Elimination of a NAP provides an estimated monthly cost save of $9K
- 4 NAPs identified for potential elimination: 4 NAPs X 9K = $36K (estimated)

Recommendation: Kan-ED NAP/Circuit Consolidation

Project Cost Breakdown:

Estimated Total Resource Hours:	160
Estimated Resource Cost:	$28,000
Estimated Capital Cost:	$0

Assumptions:
- Due diligence effort is required to validate estimated cost savings
- Minimum NAP requirements are at least two providers connecting at least two constituents
- Candidate NAPs for consolidation include Garden City, Hutchinson, Holton and Allen
- Kan-ED Network Assessment, TEM and Data Flow outputs will be key inputs to this initiative
- Implementation of consolidation performed by internal support staff

Constraints for Implementation:
- Termination penalties could be applicable for existing hardware, circuit and maintenance contract(s)

Next Steps:
- Provide NAP and Circuit Decommission Recommendations
- Develop Implementation Plan
- Procure and Implement Replacement Circuits
- Decommission Circuits and Equipment
- Initiate Contact Termination and Termination Penalty Process

Next Steps - Project Initiatives

Category: **Network Consolidation**

Description:
- Short Term: Pilot Kan-ED backbone migration onto the KDOT dark fiber in Kansas City, Topeka and Wichita as a "proof of concept" to minimize risk of a large scale migration
- Long Term: Develop a new design for the Kan-ED optical backbone to interconnect a new ring for the NAPs west of Topeka, e.g., Junction City, Salina, and Victoria

Cost Save Opportunity:
- Replacement of carrier provided services with dark fiber will provide monthly cost saves

Recommendation: Kan-ED Backbone Consolidation

Project Cost Breakdown:

Estimated Total Resource Hours:	400
Estimated Resource Cost:	$70,000
Estimated Capital Cost:	Add'l Analysis Required

Assumptions:
- Assumes that KDOT fiber can be leveraged to support Kan-ED
- Data Flow Analysis, Kan-ED and KanWIN Network Assessments will be key inputs to this initiative
- Cost savings opportunities will not be realized until backbone can be re-architected to leverage larger scale deployment
- Implementation of consolidation performed by internal support staff

Constraints for Implementation:
- Kan-ED legislation prohibiting use of State owned network resources
- Kan-ED legislation prohibiting competition against existing carrier contracts
- KDOT approval to support Kan-ED network
- Support for non-government constituents of Kan-ED
- Access to detailed documentation of fiber plant and ONS infrastructure
- Interoperability between Cisco and Juniper platforms needs to be confirmed and tested

Next Steps:
- Obtain KDOT Approval of Proposal
- Develop Kan-ED Optical Backbone Network Detailed Design
- Implement and Test Kan-ED Optical Backbone
- Develop Long Term Kan-ED Optical Backbone Feasibility and Strategy

Next Steps - Project Initiatives

Category: **Network Consolidation**

Description:
-Enhance, secure and consolidate existing peering points to facilitate ubiquitous access to the resources available on each individual network

-**Cost Save Opportunity:**
- Enabler for Shared Service recommendations

Recommendation: State Network Peering Points

Project Cost Breakdown:

Estimated Total Resource Hours:	Add'l Analysis Required
Estimated Resource Cost:	Add'l Analysis Required
Estimated Capital Cost:	Add'l Analysis Required

Assumptions:
- KanWIN, KanREN and Kan-ED Network Assessments and Data Flow outputs will be key inputs to this initiative
- Additional security requirements will need to be gathered from detailed network assessments

Constraints for Implementation:
- None identified.

Next Steps:
- Validate Peering Requirements
- Develop Peering Point Detailed Design
- Implement and Test Peering Points

Next Steps - Project Initiatives

Category: **Shared Services**

Description:
- Leverage peering points to establish a utility model for shared services across the three networks

Cost Save Opportunity:
- Enabler for Shared Service recommendations

Recommendation: Shared Service Model

Project Cost Breakdown:

Estimated Total Resource Hours:	Add'l Analysis Required
Estimated Resource Cost:	Add'l Analysis Required
Estimated Capital Cost:	Add'l Analysis Required

Assumptions:
- Work will focus on developing operational processes and investment model for shared services

Constraints for Implementation:
- Balancing requirements of each organization against consistent standards
- Method of shared investment and cost allocation

Next Steps:
- Define Shared Services Support Model, Processes and Tools
- Define Investment and Cost Allocation Model

Next Steps - Project Initiatives

Category: **Shared Services**

Description:
- Develop standards and best practice guidelines on QoS policies implemented across the three networks

Cost Save Opportunity:
- N/A

Recommendation: Qos Design Standardization

Project Cost Breakdown:

Estimated Total Resource Hours:	80
Estimated Resource Cost:	$14,000
Estimated Capital Cost:	$0

Assumptions:
- Data Flow and Peering Point Design outputs will be a key input to this initiative
- Implementation of standard performed by internal support staff

Constraints for Implementation:
- Balancing requirements of each network against consistent standards
- Data flows and IP ports/services might not currently be determined

Next Steps:
- QoS standard defined by Technology Advisory Council
- Determine IP Ports & Services of "Interesting Traffic" for QoS policies
- Develop QoS policy configuration standards
- Apply Standard to Network Devices
- Test QoS Policies

Next Steps - Project Initiatives

Category: **Shared Services**

Description:
- Develop standards and best practice guidelines on Multicast policies implemented across the three networks

Cost Save Opportunity:
- N/A

Recommendation: Multicast Design Standardization

Project Cost Breakdown:

Estimated Total Resource Hours:	80
Estimated Resource Cost:	$14,000
Estimated Capital Cost:	$0

Assumptions:
- All Multicast network solutions are not consistent
- All Multicast network solutions are not designed for high-Availability
- All network devices in the Multicast routing paths may not be optimized using Best Practice Standards
- KanWIN, KanREN and Kan-ED Network Analysis outputs will be key inputs to this initiative
- Implementation of Standards performed by internal support staff

Constraints for Implementation:
- Determination of existing state-wide Class-D IP addressing
- Router and switch IOS upgrades may be required to support IGMP and CGMP

Next Steps:
- Multicast standard defined by Technology Advisory Council
- Design state-wide Class-D IP Addressing Strategy
- Confirm all Multicast Source Hosts
- Design state-wide high-availability Multicast Architecture Standards
- Apply Multicast Design to affected devices

Next Steps - Project Initiatives

Category: **Shared Services**

Description:
- Enhance the enterprise strategy for delivering rich media across the three networks using cost effective, next generation technologies

Cost Save Opportunity:
- Reduction of large WAN circuit requirements per H.264 technology implementation
- Reduction in the number of video endpoints (4 to 1), monitors and network connections per class room
- Reduction in hardware and software maintenance costs

Recommendation: Rich Media (Video)

Project Cost Breakdown:

Estimated Total Resource Hours:	160 (Strategy Only)
Estimated Resource Cost:	$28,000
Estimated Capital Cost:	Requires Add'l Analysis

Assumptions:
- Class rooms require multiple network connections to support the hardware solution
- Class rooms leverage 4 Video endpoints and monitors per room
- Video solution and design are not leveraging next generation technologies - e.g. H.264 & best practice principals
- Detailed video hardware cost data was not made available
- Implementation of solution performed by internal support staff

Constraints for Implementation:
- Hardware and software upgrades might be required
- Termination penalties could be applicable for existing hardware maintenance contract(s)

Next Steps:
- Conduct Detailed Rich Media Assessment and Strategy
- Redesign of Video Call Flow Patterns
- Develop Enterprise Video Solution Strategy and Technology Roadmap
- Upgrade OS on Video Endpoints, where applicable, and Configure Hardware Feature Sets
- Upgrade Video Endpoint Hardware where applicable

Next Steps - Project Initiatives

Category: Operations

Description:
- Capture data flows at all critical network touch points to ensure changes do not impact services, applications or other portions of the network

Cost Save Opportunity:
- Minimize production downtime during implementation of Network Consolidation recommendations

Recommendation: Documentation of Network Data Flows

Project Cost Breakdown:

Estimated Total Resource Hours:	320
Estimated Resource Cost:	$71,000
Estimated Capital Cost:	$0

Assumptions:
- Predictable data flows are not documented for existing IP services or critical enterprise applications
- Network tools are not leveraged to obtained data flows
- Data flows can be identified with network probes
- Network Probes would be deployed at key network aggregation points
- Probes would be deployed in a maximum of 10 aggregation points
- Gaps would be addressed by leveraging existing performance monitoring tools
- Network polling period would be for a week's duration
- Polling would use a phased approach to accommodate volume of aggregation points

Constraints for Implementation:
- Existing tool sets may not be available to capture the network data flows
- Inventory of critical IP services and applications must be documented, ranked and prioritized
- Security policies (IPS, IDS, ACLs and Firewalls) might require temporary modification to support the deployment of the probes

Next Steps:
- Inventory Critical Enterprise Network Applications and IP Services
- Deploy Probes to Capture Network Data Flows
- Conduct Interviews if deemed appropriate
- Correlate Data Captures
- Document findings

Next Steps - Project Initiatives

Category: **Operations**

Description:
- Migrate Kan-ED Network Operations and Support to KanWIN to achieve operational economies

Cost Save Opportunity:
- Annual cost save of $475K for lower staffing (leveraging BOT tools & processes)

Recommendation: Realign Kan-ED NOC Services

Project Cost Breakdown:

Estimated Total Resource Hours:	500
Estimated Resource Cost:	$90,000 (One time) $525,000 (Recurring)
Estimated Capital Cost:	$50,000

Assumptions:
- 5 FTEs will be required to support Kan-ED's Network Operations Centers
- Fully Burdened Rate of $105K/yr (~$50/hr) for an FTE
- Current Kan-ED support contract is approximately $1M/year
- No additional network management tools will be required

Constraints for Implementation:
- Hiring 5 qualified support FTEs to support Kan-ED
- Knowledge transfer from KanREN to new support organization

Next Steps:
- Define Kan-ED Support Requirements
- Evaluate KanWIN Capability to Support Kan-ED
- Develop Operational Transition Plan
- Implement Operational Transition Plan

Next Steps - Project Initiatives

Category: Operations

Description:
- Audit existing carrier service contracts, billing services and operational processes to achieve savings opportunities

Cost Save Opportunity:
- Reduce existing WAN expenses and establish cost avoidance
- Historical billing error recovery
- Optimize operational support processes and procedures
- Reduce contracted rate structure

Recommendation: Telecom Expense Management

Project Cost Breakdown:

Estimated Total Resource Hours:	Add'l Analysis Required
Estimated Resource Cost:	Add'l Analysis Required
Estimated Capital Cost:	Add'l Analysis Required

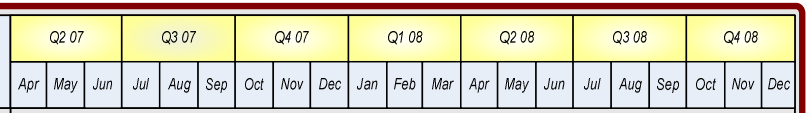
Assumptions:
- Existing carrier contracts can be renegotiated
- All expense records are available for audit
- An accurate circuit inventory is available
- Current operational processes are defined

Constraints for Implementation:
- Availability and access to telecom expense records
- Timely and accurate capture of existing inventory, processes and procedures
- Termination penalties of existing services and maintenance contracts

Next Steps:
- Confirmation of size and scope of the TEM Project
- Assess and Adjust WAN Expenses
- Assess and Adjust WAN Operational Policies

Project Gantt Summary

ID	Project Milestones	Start	Finish	Duration
1	**Kansas State Network Consolidation Project**	4/2/2007	9/16/2008	382d
2	***Standardization***	4/2/2007	10/12/2007	140d
3	Design & Equipment Standards	8/20/2007	10/12/2007	40d
4	KanREN Network Assessment	4/2/2007	6/8/2007	50d
5	KanED Network Assessment	6/11/2007	8/17/2007	50d
6	Kan-ED Carrier Interconnect Standards	4/2/2007	5/25/2007	40d
7	***Network Consolidation***	10/15/2007	5/23/2008	160d
8	Kan-ED NAP/Circuit Consolidation	10/15/2007	11/9/2007	20d
9	Kan-ED Backbone Migration	11/12/2007	1/18/2008	50d
10	State Network Peering Points (Additional scope analysis required)	4/2/2007	4/6/2007	5d
11	***Shared Services***	6/1/2007	11/29/2007	130d
12	Shared Service Model (Additional scope analysis required)	4/2/2007	4/6/2007	5d
13	QoS Design Standardization	10/15/2007	10/26/2007	10d
14	Multicast Design Standardization	10/15/2007	10/26/2007	10d
15	Rich Media (Video)	9/3/2007	9/28/2007	20d
16	***Operations***	4/2/2007	9/16/2008	382d
17	Documentation of Network Data Flows	8/20/2007	10/12/2007	40d
18	Realign Kan-ED NOC Services	1/2/2008	9/16/2008	185d
19	Telecom Expense Management (Additional scope analysis required)	4/2/2007	4/6/2007	5d



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Project Cost Summary

Category	Recommendation	Estimated Cost Saves	Estimated Resource Hours (External)	Estimated Resource Cost (External)	Estimated Capital Cost
Standardization	**Design Standards**	N/A	1120 Hours (Includes Network Assessments)	$200K	None
	Equipment Standards	N/A	- Effort rolled into Network Design Standardization estimate above	- Effort rolled into Network Design Standardization estimate above	None
	Kan-ED Carrier Interconnect Standards	N/A	320 hours	$56K	None
Network Consolidation	**Kan-ED NAP/Circuit Consolidation**	$816K per year	160 hours	$28K	None
	Kan-ED Backbone Migration	TBD - Requires further study	400 hours (pilot and strategy)	$70K	TBD - Requires further study
	State Network Peering Points	N/A	Additional scope analysis required	Additional scope analysis required	Additional scope analysis required
Shared Services	**Shared Service Model**	N/A	Additional scope analysis required	Additional scope analysis required	Additional scope analysis required
	QoS Design Standardization	N/A	80 hours	$14K	None
	Multicast Design Standardization	N/A	80 hours	$14K	None
	Rich Media (Video)	TBD - Requires further study	160 hours (Strategy Only)	$28K	TBD - Requires further study
Operations	**Documentation of Network Data Flows**	N/A	320 hours	$71K	None
	Realign Kan-ED NOC Services	$475K per year	500 hours	- $90K (implementation) - $525K (annual to support KanWIN FTEs)	- $50K (software licenses)
	Telecom Expense Management	TBD - Requires further study	Additional scope analysis required	Additional scope analysis required	- Additional scope analysis required
		$1,291,000	**3140 Hours**	**$571,000 (One Time)** **$525,000 (Recuring)**	**$50,000**

State of Kansas

Appendix

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Network Comparison Matrix

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Attribute	KanREN	KanWIN	Kan-ED	Total	Score	Cor %
Current Functions				18	11	61%
Broadband Technology-Based Network	x	x	x	3	3	
Transport to Internet Access Points	x	x		3	2	
Transport for internal applications and services	x	x	x	3	3	
Access to State based Mainframe and Host Services		x		3	1	
Transport for Intra-Agency applications		x		3	1	
Transport for Public E-Government applications		x		3	1	
User Community Serviced				24	12	50%
K-12	x		x	3	2	
Higher Education	x		x	3	2	
Public Libraries	x		x	3	2	
Hospitals	x		x	3	2	
State Agencies		x		3	1	
Local Government (access to state resources)		x		3	1	
State Residents (web-based services)		x		3	1	
Other not-for-profit Organizations	x			3	1	
Applications				21	13	62%
Interactive Distance Learning	x		x	3	2	
Video Conferencing	x	x	x	3	3	
Public Internet	x	x		3	2	
Internet2	x		x	3	2	
Telemedicine			x	3	1	
State Government Applications (payroll, budget, accounting, etc.)	x	x		3	2	
E-Government Services for state residents		x		3	1	
Funding Model				9	3	33%
State Funded via KUSF/SGF			x	3	1	
Fee Based (fee established by membership)	x			3	1	
Fee/Rate Based (rates established by DISC)		x		3	1	
Governance Model				18	6	33%
Kansas Board of Regents			x	3	1	
Advisory Council			x	3	1	
501(c)(3)	x			3	1	
Board of Directors	x			3	1	
Secretary of Administration		x		3	1	
Policy Board		x		3	1	
Network Backbone				42	27	64%
Backbone Speeds						
- Medium Speed Backbone (Ring Based OC-3 ~ 155Mb)		x	x	3	2	
- High Speed Backbone (1Gigabit Ethernet)	x			3	1	
Backbone Circuits						
- Dark Fiber (State Owned)	x	x		3	2	
- Dark Fiber (Other)	x			3	1	
- Leased circuit infrastructure	x		x	3	2	
Design Considerations						
- Redundancy (multiple paths, carrier diversity)	x	x	x	3	3	
- Reliability (99.99 Availability)	x	x	x	3	3	
- Transit Network (common backbone for service providers)			x	3	1	
- Topeka Hub (access to shared state applications, eGovernment)		x		3	1	
- Extended-Edge Network (reduction of last mile costs to constituents)			x	3	1	
MPLS Enabled	x	x		3	2	
Internet Backbone POP	x	x		3	2	
Customer traffic aggregated to access points (eg, NAPs)	x	x	x	3	3	
Peering between KanWIN, KanREN & KanED Backbones	x	x	x	3	3	
Network Management				12	6	50%
KanREN NOC Services	x		x	3	2	
BOT NOC Services (7x24x365)		x		3	1	
Open Source Network Management tools	x			3	1	
Enterprise Class Network Management tools	x	x		3	2	
Network Services & Protocols				42	23	55%
Routing Protocols						
- BGP	x	x	x	3	3	
- IS-IS			x	3	1	
- OSPF	x	x	x	3	3	
- EIGRP		x		3	1	
- RIPv2		x		3	1	
Nework Services						
- DLSW		x		3	1	
- GRE Tunnelling (IPX traffic)		x		3	1	
- QoS	x	x		3	2	
- Multicast	x	x		3	2	
IP Addressing						
- IPv6	x			3	1	
- IPv4	x	x	x	3	3	
Token Ring (16M)		x		3	1	
Base Level Security (packet filtering - "ACL")	x		x	3	2	
Enhanced Security (firewalls, intrusion detection, prevention, encryption)		x		3	1	
Wide Area Network Infrastructure Vendor				15	7	47%
Cisco	x	x	x	3	3	
Foundry	x			3	1	
Redback		x		3	1	
Juniper			x	3	1	
Nortel		x		3	1	
"Last Mile" Model & Strategy				9	4	44%
Circuit and CPE Provisioned & Supported by Organization	x	x		3	2	
Circuit and CPE Provisioned & Supported by Service Provider			x	3	1	
Customer Premise Equipment Subsidized			x	3	1	
				210	112	53%

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