A Low Latency, Highly Available Wide Area Network (WAN)

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Acknowledgement and Disclaimer

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WISP’s Communication Needs

• Move synchrophasor data around the entire Western Interconnection among 19 parties (everyone with a phasor measurement unit (PMU) on their system)
• Low latency, high volume important
WISP’s Communication Needs

• High availability, reliability, and cyber security:
  o Expect operators to use synchrophasor data to make operating decisions in near real time
  o Possible use of WAN for automated controls
**WISP Specified:**

- Redundant backbone
- Private, dedicated infrastructure
- 24/7 dedicated Network Operation Center (NOC)
- Centrally managed access by Peak Reliability
- Contract with each Participant for ‘last mile’ connection
WISP Specified (con’t):

- One-way latency $\leq 30$ ms average over 10 minutes between edge routers
- Jitter $\leq 2$ ms average over 10 minutes
- Availability to Reliability Centers 99.997%
- Availability to single access participant 99.94%
- Encrypted transmission
- Capable of performance at high volume data transmission – 10X expected initial signal volume of 2100 measurements
All WISP Participants connected to WAN
All Participants are transmitting synchrophasor data to Peak Reliability, many are sharing data peer-to-peer
WAN Performance has exceeded requirements
  - Average latency 19 ms (30 ms specified)
  - Average jitter 1.4 ms (2 ms specified)
  - Availability at Reliability Centers and Dual Access Participants has been 100 percent
HARRIS NETWORK EXPERIENCE

• Peak Reliability (formerly Western Electricity Coordinating Council)
  – Western Interconnection Synchrophasor Project (WISP) WAN

• Department of Transportation
  – Federal Aviation Administration (FAA)
    • FAA Telecommunications Network (FTI) Contract
    • Dual Core “Red Core” Network Contract

• Department of Defense
  – Defense Information Systems Agency (DISA)
    • DISN Access Transport Services (DATS) Contract

• Private Industry
  – Harris Corporation
    • Harris Corporation Data/Voice Network

• Healthcare
  – Health Management Associates (HMA)
    • Network Infrastructure Transition Contract
• Harris Trusted Enterprise Network (HTEN)
  – A Nationwide, Terrestrial, High Capacity Backbone
    • Multi-Protocol Label Switched (MPLS) Wide Area Network (WAN)
    • > 15,000 Fiber Route Miles
    • 100 gigabits of capacity on each route
    • > 60 points of presence across the US
    • Last mile access via local telecommunication providers
  – Designed to Transport Mission Critical Voice, Video, and Data Within a Private Environment
  – Predicated on Four (4) Major Tenets:
    • Private/Secure
    • High Availability
    • High Throughput/Low Latency
    • Focused Customer Care
HTEN DIFFERENTIATORS

Private/Secure
- Separate PE Routers and Switching Equipment
- Defense in Depth Security Approach
- Private PE Routers and Separate VRF Tables
- No Direct Peering Points with the Public Internet
- Secure Gateway Services
- Multiple Layers of Security and Optional Security Services

High Availability
- Equipment Redundancy
- Physical and Logical Circuit Diversity
- 99.999% Availability

High Throughput/Low Latency
- Customized Routing Plans
- Deterministic Quality of Service (QoS)
- < 50ms of Latency (One Way) Across the U.S.

Customer Focused Care
- 24 x 7 x 365 Harris Operations Center
- 24 x 7 x 365 Security Operations Center
- Measures of Effectiveness (MOEs)
- Managed Service Network Solutions
- System Domain Focus
**WISP WAN ARCHITECTURE**

- **Private Optical Infrastructure**
  - No internet connectivity
  - Dedicated provisioning team
  - Field Tech Force cleared via federal background check
  - Allocated portion optical transport for PEAK purpose built WAN

- **Private MPLS CORE WECC Routers**
  - Routers only used for WECC services
  - Private IP address space for router management

- **Security Systems Guard the Infrastructure**
  - Firewalls
  - Anti-virus appliances
  - Intrusion prevention systems
  - 24 x 7 security operations control center
  - Internal audits

- **Security Systems Guard the Data**
  - Key Server
  - GETVPN
# WISP WAN SLA / METRICS

<table>
<thead>
<tr>
<th>Service Level Category / Description</th>
<th>Monthly Performance Target based on 24/7 operation</th>
<th>Weighting Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPLS Core Network</td>
<td>100.00%</td>
<td>40%</td>
</tr>
</tbody>
</table>
| Participating Entity with single access without diversity | 100-99.95%  
99.949-99.44%  
99.43-98.89%  
98.88-0.00% | 0%  
10%  
30%  
50% |
| Maximum MPLS Latency (one way)       | 30ms average per 10 minute period                 | 10%                  |
| WAN MPLS Jitter.                     | 2ms average per 10 minute period                  | 10%                  |
| Unauthorized WAN Move/Add/Change.    | 100% change success rate                          | 2%                   |

### Performance Targets

**Delivered Latency**

<table>
<thead>
<tr>
<th>UTILITY</th>
<th>LATENCY*</th>
<th>WITH GetVPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>21 ms</td>
<td>24 ms</td>
</tr>
<tr>
<td>2</td>
<td>18 ms</td>
<td>21 ms</td>
</tr>
<tr>
<td>3</td>
<td>11 ms</td>
<td>13 ms</td>
</tr>
<tr>
<td>4</td>
<td>19 ms</td>
<td>22 ms</td>
</tr>
<tr>
<td>5</td>
<td>20 ms</td>
<td>22 ms</td>
</tr>
<tr>
<td>6</td>
<td>22 ms</td>
<td>25 ms</td>
</tr>
<tr>
<td>7</td>
<td>18 ms</td>
<td>24 ms</td>
</tr>
</tbody>
</table>

* Latency Requirement <= 30 ms
BACKGROUND

- Objective – rapid response to address and resolve network issues and outages
- Dual Access Facilities experienced 100% availability in 2013
- In 2013, there were 45 outage events with an average MTTR of 1.66 hour

MTTR = \frac{\text{Sum of Outage Time (over period)}}{\text{Sum of Outages (over period)}}
Service Availability
Single-Access Facility

<table>
<thead>
<tr>
<th>Month</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 2013</td>
<td>0.99976</td>
</tr>
<tr>
<td>September 2013</td>
<td>0.99886</td>
</tr>
<tr>
<td>October 2013</td>
<td>0.99988</td>
</tr>
<tr>
<td>November 2013</td>
<td>0.99995</td>
</tr>
<tr>
<td>December 2013</td>
<td>1.00000</td>
</tr>
<tr>
<td>January 2014</td>
<td>1.00000</td>
</tr>
</tbody>
</table>

**September 2013**

- Telecommunications Partner maintenance scheduled as non-service affecting went awry. 5-hour outage incurred.
## Service Availability

### Reliability Centers

<table>
<thead>
<tr>
<th>Month</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 2013</td>
<td>1.00000</td>
</tr>
<tr>
<td>September 2013</td>
<td>1.00000</td>
</tr>
<tr>
<td>October 2013</td>
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<tr>
<td>November 2013</td>
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<tr>
<td>December 2013</td>
<td>1.00000</td>
</tr>
<tr>
<td>January 2014</td>
<td>1.00000</td>
</tr>
</tbody>
</table>

- **Required Availability**

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[Graph showing service availability for each month with required availability highlighted.]
Backbone Events

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Scheduled Outages</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>9</td>
<td>8</td>
<td>4</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Unscheduled Outages</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

Background

- 48 Scheduled Outages
- 28 Unscheduled Outages
- All WAN Point of Presence (POP) locations have a minimum of 3 routable paths
- 0 Impacts to Peak Reliability services
Peak Reliability
Participating Entity Bandwidth Utilization (DS1)
January 2014

<table>
<thead>
<tr>
<th>Configured</th>
<th>1536</th>
<th>1536</th>
<th>1536</th>
<th>1536</th>
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<th>1536</th>
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<th>1536</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Receive kbps</td>
<td>111.54</td>
<td>64.9</td>
<td>1.78</td>
<td>1.93</td>
<td>780.34</td>
<td>1001.23</td>
<td>73.94</td>
<td>47</td>
<td>86.29</td>
<td>1.84</td>
<td>1.83</td>
<td>0.04</td>
<td>0.04</td>
<td>1.12</td>
<td>117.88</td>
<td>108.38</td>
<td>73.94</td>
<td>47</td>
<td>86.29</td>
</tr>
<tr>
<td>Peak Receive kbps</td>
<td>124.1</td>
<td>70.23</td>
<td>3.6</td>
<td>4.17</td>
<td>830.4</td>
<td>1095.71</td>
<td>79.1</td>
<td>51.18</td>
<td>100.13</td>
<td>3.51</td>
<td>3.16</td>
<td>1.31</td>
<td>1.3</td>
<td>2.94</td>
<td>133.88</td>
<td>116.6</td>
<td>3.99</td>
<td>538.35</td>
<td>3.64</td>
</tr>
<tr>
<td>Average Transmit kbps</td>
<td>314.29</td>
<td>272.41</td>
<td>1058.64</td>
<td>323.19</td>
<td>2.21</td>
<td>215.4</td>
<td>288.65</td>
<td>250.08</td>
<td>197.55</td>
<td>311.83</td>
<td>66.24</td>
<td>79.73</td>
<td>55.51</td>
<td>270.93</td>
<td>512.83</td>
<td>515.61</td>
<td>587.63</td>
<td>293.56</td>
<td>43.35</td>
</tr>
<tr>
<td>Peak Transmit kbps</td>
<td>329.45</td>
<td>287.97</td>
<td>1214.79</td>
<td>355.83</td>
<td>8.14</td>
<td>240.7</td>
<td>302.58</td>
<td>286.69</td>
<td>212.77</td>
<td>326.52</td>
<td>78.48</td>
<td>522.54</td>
<td>125.65</td>
<td>289.05</td>
<td>542.42</td>
<td>554.35</td>
<td>618.76</td>
<td>310.97</td>
<td>49.39</td>
</tr>
</tbody>
</table>

Utilization (kbps)
1) Rate Limit VLAN #1
2) Size VLAN #1 to exceed expected Traffic

1) Rate Limit VLAN #2
2) Size VLAN #2 to exceed expected Traffic

- Virtual LANs (VLAN) create multiple layer-3 networks within a layer-2 network – mutually isolating packets
- Network backbone allocation can be expanded to handle increased traffic load
Upgrades

• Update router configuration, VLANs, CoS, etc. 10-15 business days
• Bandwidth increases 90-120 days
• Adding redundancy/diversity – new telco and equipment delivery – 90-180 days

New Sites

• 90-120 days

New Network

• Private Network establishment – 150-180 days ARO
• Site transition on-ramping - 180 days ARO
Welcome to the Junos Pulse Secure Access Service

Web Bookmarks

- Remedy Ticketing System
- WECC Orion Network Performance Monitoring
- WECC Sharepoint Portal

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Questions?

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