

D&NMTT

# Report on the 2014 Network Survey

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# New NASPI Networking Survey

- ▣ In Nov 2014, the NASPI Data & Network Management Task Team (D&NM-TT) surveyed networking practice in the NASPI community.
- ▣ Objectives:
  - Obtain an accurate picture of installed networking infrastructure for power grid.
  - Provide a basis for future periodic re-assessments, to gauge progress.
  - Highlight some open technical issues

# Survey Design

- ▣ Within substations and control centers, existing LAN technology is fairly mature. Therefore, survey emphasized wide area networking issues -- WANs
- ▣ Survey shape: broad & shallow vs. narrow & deep? Compromise...
- ▣ Pressure to expand scope
  - Many issues are related to networking.
- ▣ **32 questions, ~170 sub questions, 25 pages.**

# Trying to Make it Easy

- ▣ PNNL donated the use of their survey engine.
- ▣ Mostly multiple-choice questions, with free-form “*other*” options.
- ▣ Multiple answers generally allowed.
- ▣ Final report with bar graphs will be on NASPI web site.

# The Outcome

- ▣ Captured broad range of responses from many major transmission owners and reliability coordinators.
- ▣ Got about 55 responses.
- ▣ We eliminated ~30 because of:
  - fragmentary responses,
  - duplicates,
  - responses from companies or universities that are not part of a large regional power grid.

# Some Caveats

1. Corporate anonymity -- we will not publicly identify the respondents nor reveal their answers.
2. Results should be *representative* of North American synchrophasor deployment , **but it was not a statistically valid sample.**
3. We captured center of the distribution of PMU aspirations. Some at both extremes chose to not respond.
4. Small sample size ( $\leq 25$ )

# Question Categories

## Internet Reference Model

Application Layer  
(eg, C37.118)

Middleware Layer

Transport Layer  
(eg, TCP, UDP)

Internetwork (IP) Layer

Sub-network Layer

Questions can be  
classified  
by protocol layer.

# Example: Sub-network Layer Questions






- Who is your WAN provider?
- WAN data transport technology used?
  - (Example report on next slide)
- WAN is managed by?
- WAN reliability/resilience features are?



## 5. Your wide-area network transport is based upon:

(check all that apply)

(Respondents were allowed to choose multiple responses)

Response	Chart	Frequency	Count
<b>MPLS</b>		<b>56.0%</b>	<b>14</b>
Wide-area Ethernet		40.0%	10
<b>SONET</b>		<b>56.0%</b>	<b>14</b>
Frame Relay		16.0%	4
Other (please specify)		24.0%	6
		<b>Valid Responses</b>	<b>25</b>

'Frequency' is fraction of responders who made this choice.  
Because of multiple responses, percentages add up to >100%.

Because of small sample, percentages should not be taken too literally.

VPLS

Microwave

T3/T1

## 5. Your wide-area network transport is based upon:

(check all that apply)

(Respondents were allowed to choose multiple responses)

Response	Chart	Frequency	Count
<b>MPLS</b>		<b>56.0%</b>	<b>14</b>
Wide-area Ethernet		40.0%	10
<b>SONET</b>		<b>56.0%</b>	<b>14</b>
Frame Relay		16.0%	4
Other (please specify)		24.0%	6
		<b>Valid Responses</b>	<b>25</b>
		<b>Total Responses</b>	<b>28</b>

## 5. Your wide-area network transport is based upon: (Other, please specify)

Response	
digital microwave, RF PTP, wimax	<p>Conclude: MPLS and SONET are roughly equal, followed by Wide-Area Ethernet. There is still some Frame Relay, although carriers are dropping FR support</p>
T1, 56kBs	
VPLS	
Microwave	
T3/T1	

# Networking Needs Depend on Roles

- E.g. Reliability Coordinators vs. Transmission Owners.
  - Reliability Coordinators do not directly “control” physical resources, so they have less need for an internal private company network.

G + TO + RC

TO

RC

Response	Chart	Frequency	Chart	Frequency	Chart	Frequency
Your company		65.4%		85.7%		14.3%
Telephone company (telco)		57.7%		60.0%		57.1%
Third-party private network (i.e., not a telco - e.g., Harris)		30.8%		20.0%		42.9%
Internet service provider (ISP)		23.1%		13.3%		28.6%
Other (please specify)		15.4%		6.7%		28.6%


# Network and Transport Layer Questions

- ▣ What transport/internet network layers used  
(e.g., TCP/IP vs. UDP/IP):
  - for PMU data streaming?
  - for PMU configuration and control?
- ▣ SLA (if any) with service provider includes?
- ▣ What QoS mechanisms are used?

# Questions on Application Layer

- ▣ Intended PMU Uses
- ▣ PMU data delivery architecture
- ▣ PMU data format standard(s)
- ▣ Redundancy in data delivery
- ▣ PMU data rate

# Interesting Findings (1)

- ▣ PMU data delivery architecture (Q#7)
  - ~80% -- “PMU data is **time-aligned** by at least one PDC before it gets to the control room.”
  - ~25% -- “PMU data is sent directly to the control room, where it may be time-aligned for applications.”
  
- ▣ Standards used for PMU data streaming (Q#8)
  - C37.118 32%
  - C37.118-2005 56%
  - C37.118-2011 24%
  - IEC 61850-90.5 0% 

# Interesting Findings (2)

- ▣ Ethernet reigns in substations, but there are still some serial lines. (Q#14)
  - Ethernet: ~96% of respondents
  - Serial lines: ~43% of respondents
  
- ▣ PMU clock sources (Q#28)
  - ~95% use GPS as their timing source for networks and PMUs
  - ~79% of the TOs use IRIG-B

# SLA findings

## ▣ What does the SLA with your WAN service provider cover?

Bandwidth	30%
Availability	25%
Latency	20%
Jitter	10%
No SLA	60%

## ▣ Does your service provider alert you if SLA is violated?

Yes	~10%	(Q#21)
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# Security Findings

- ▣ 40% of the respondents use no encryption for WAN data security. (Q#24)
- ▣ 25% don't use network access control to prevent an unauthorized device from being attached to the network. (Q#26)
- ▣ 50% of the TOs have deployed PMUs within a NERC-defined electronic security perimeter; most of those consider the synchrophasor technology a critical cyber asset. (Q#27)
- ▣ Over 50% of the respondents cannot detect if their time source has been compromised. (Q#29)

# Open Issues

- ▣ ~67% of respondents have no Quality of Service (QoS) mechanism to ensure real time delivery of PMU data. (Q#12)
- ▣ A majority of the respondents don't monitor latency or jitter performance for specific applications. (Q#22)
- ▣ ~50% of the responding RCs use middleware for various purposes (mostly application layer publish-subscribe), but only ~9% of the TOs use middleware. (Q#17)

# Conclusions

The survey gives a pretty good picture of the current status of wide area networking for NASPInet.

What about the future?

- There are important issues – e.g., QoS, reliable clocking, security – that need more attention.

# Looking Forward

- ▣ NASPI will generally need high-volume, high-reliability networks, such as used today for broadcasting and banking. Will also need low latency.
- ▣ Current synchrophasor data network characteristics do not take advantage of recent and evolving network technology.
- ▣ These issues will be discussed by Dick Willson in the next presentation.

# Acknowledgments

- ▣ We are grateful to PNNL for the use of their survey service, and in particular to Karen Buxton and Teresa Carlon of PNNL.
- ▣ We are grateful to the hard-working responders.

Thank You