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Campus Network Architecture, Management, and Monitoring

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Agenda

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- Campus Network architecture
- Campus Network size and statistics
- Managing and monitoring the network

Network Architecture

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- Design goals and standards:
  - Always redundant, everywhere possible
  - Redundant fiber pathways diverse as possible
  - Always plan for more capacity than needed
  - Network must be managed and monitored
  - We must be able to understand what is happening on the network

Network Architecture

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- "Border" routers connect to providers
- "Core" routers connect to border routers
- Wired network "distribution" routers connect to core routers
- Wireless "distribution" routers connect to cores
- Remote site VPN routers connect to cores
- Building switches connect to distribution routers
- User switches connect to building switches

Logical Network Diagram

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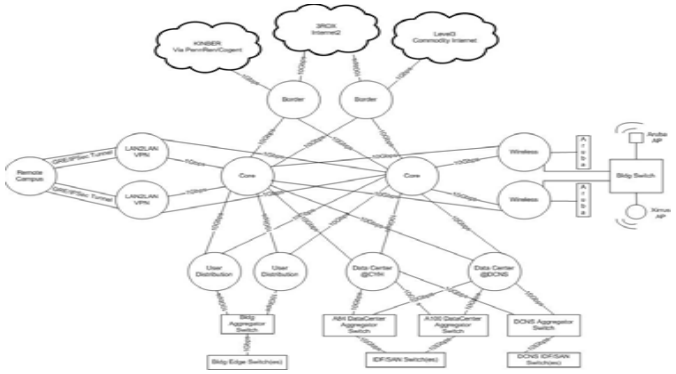

5

Physical Network Diagram

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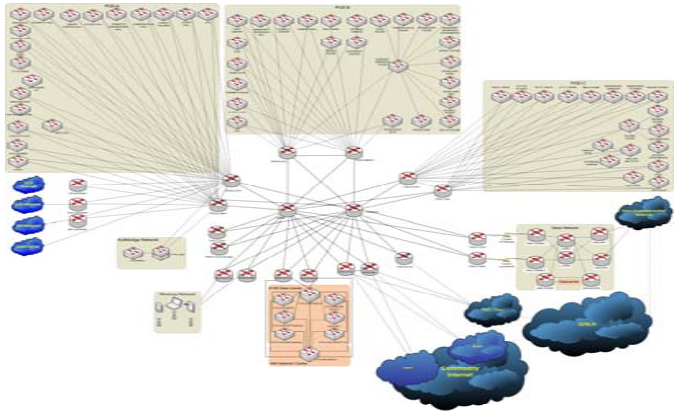

6

How Large is our Campus Network?

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- 4 major sites around the world
- ~90 buildings across main campus
- 20 enterprise class routers
- 1,000+ data switches
- 50,000+ wired outlets
- 71 miles of copper (connecting outlets to switches)
- 531 miles of fiber
- 3,000+ 802.11 wireless access points
- 5,000,000+ square feet of indoor wireless coverage
- 1-2 acres of outdoor wireless coverage (expanding in 2014)

7

How Large is our Campus Network?

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- 578 VLANs
- 884 Subnets
- 3,000+ Users
- 170,000+ Registered Machines

8

Protocols We Rely On

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- OSPF
- BGP
- Rapid Spanning-Tree
- CDP
- IPv4/v6
- TCP
- UDP
- ARP
- … and many others

9

Network Monitoring - Goals

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- To clearly understand who is doing what on your network at any time.

10

Identifying Devices

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- Information that allows a device to work on the network (Layer 2, Layer 3)
- Information about what a device is doing on the network (Layer 3)
- Information about the device itself (Layers 4-7)

11

Identifying Devices - Layer 2

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- MAC Address
  - Found in:
    - DHCP requests
    - ARP and CAM data
    - Radius Data
  - Useful for:
    - Uniquely identifying the machine
    - Possibly identifying the machine manufacturer

12

Identifying Devices – Layer 3

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- IP Address
  - Found in:
    - DNS Requests
    - ARP and CAM data
  - Useful for:
    - Uniquely identifying the machine with its network and subnet
  - Must be tied to external tool (DHCP, IPAM, Radius) to get more accounting information

13

Identifying Devices – Layer 3

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- Network Switch and Routing Information
  - Found in:
    - Switch / Router Configs and SNMP
  - Useful for:
    - Finding Real-time connection and network path information

14

Identifying Devices – Layer 3

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- Network Flow Data
  - Found in:
    - Netflow v5 and v9 data
    - Various other applications (Argus, tcpdump)
  - Useful for:
    - Discovering traffic to and from a host
    - Finding the protocols a machine is using
    - Find throughput for a machine

15

Identifying Devices – Layer 7

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- Machine Registration
  - External Application That Maintains IP addresses for specific machines
- Payload Capture
  - Netflow v9, Argus
  - Complete Packet Payload

16

Identifying Users

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- IPAM Registration
  - IP/MAC -> User Mapping
- User Based Network Access (Radius)
  - VPN
  - 802.1x
  - WPA
- Syslog
  - MAC/IP User Information

17

CMU Custom Network Monitoring Applications

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- NetReg – IPAM, DNS, DHCP Management
- Bandwidth – Netflow and Bandwidth Tool
- DNS
- DHCP
- Radius
- Netinform/NLS – Network Archive Tool
- NISC – Incident Management Tool
- BKAD – Network Telemetry Data

18

NetReg

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19

Bandwidth

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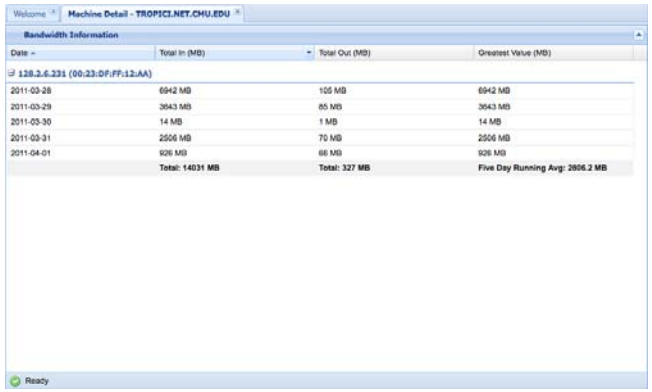

20

NetInform/NLS

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- Collects DNS, DHCP and Switch Information
- ARP, MAC Data
- Time-based

21

NetInform/NLS

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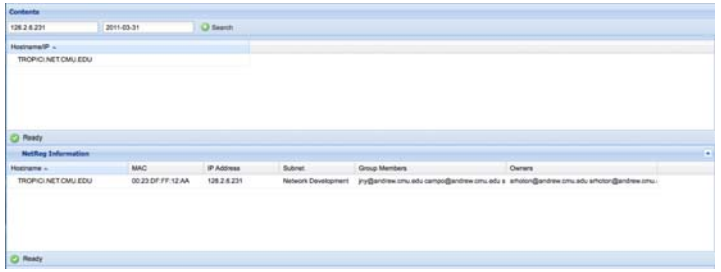

22

NISC

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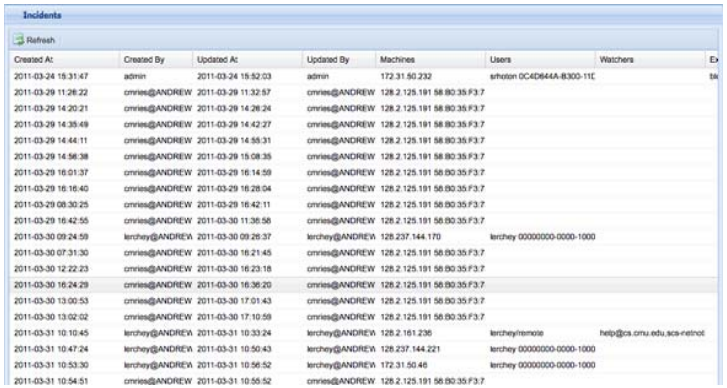

23

BKAD

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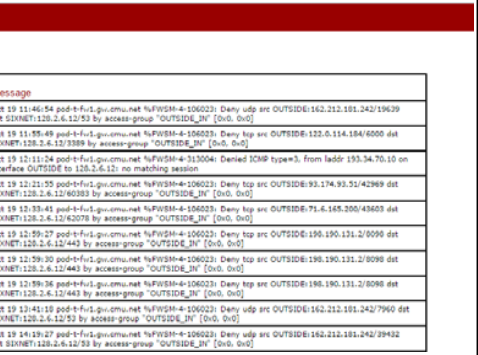

24

CMU Commercial Network Monitoring Applications

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- NetMRI (http://www.infoblox.com/en/products/netmri.html)
- NetQoS (http://www.ca.com/content/Integration/netqos.aspx)
- AirWave (http://www.arubanetworks.com/products/management-security-software-2/airwave/)
- Nagios (http://www.nagios.org/)

25

Q&A

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- Questions?

26