Network and Computer Security in the Fermilab Accelerator Control System

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Agenda

I. Overview and Network Layout

II. Balancing Risks vs. Usability

III. Network Layer Protection

IV. OS/Application Layer Protection

V. Access Options

VI. Future Directions

I. Overview

- Controls the hardware of the accelerator
- A large experimental physics apparatus which is being constantly adjusted and improved
- Intrinsically engineered to keep software errors from causing equipment damage
- No environmental or life safety systems

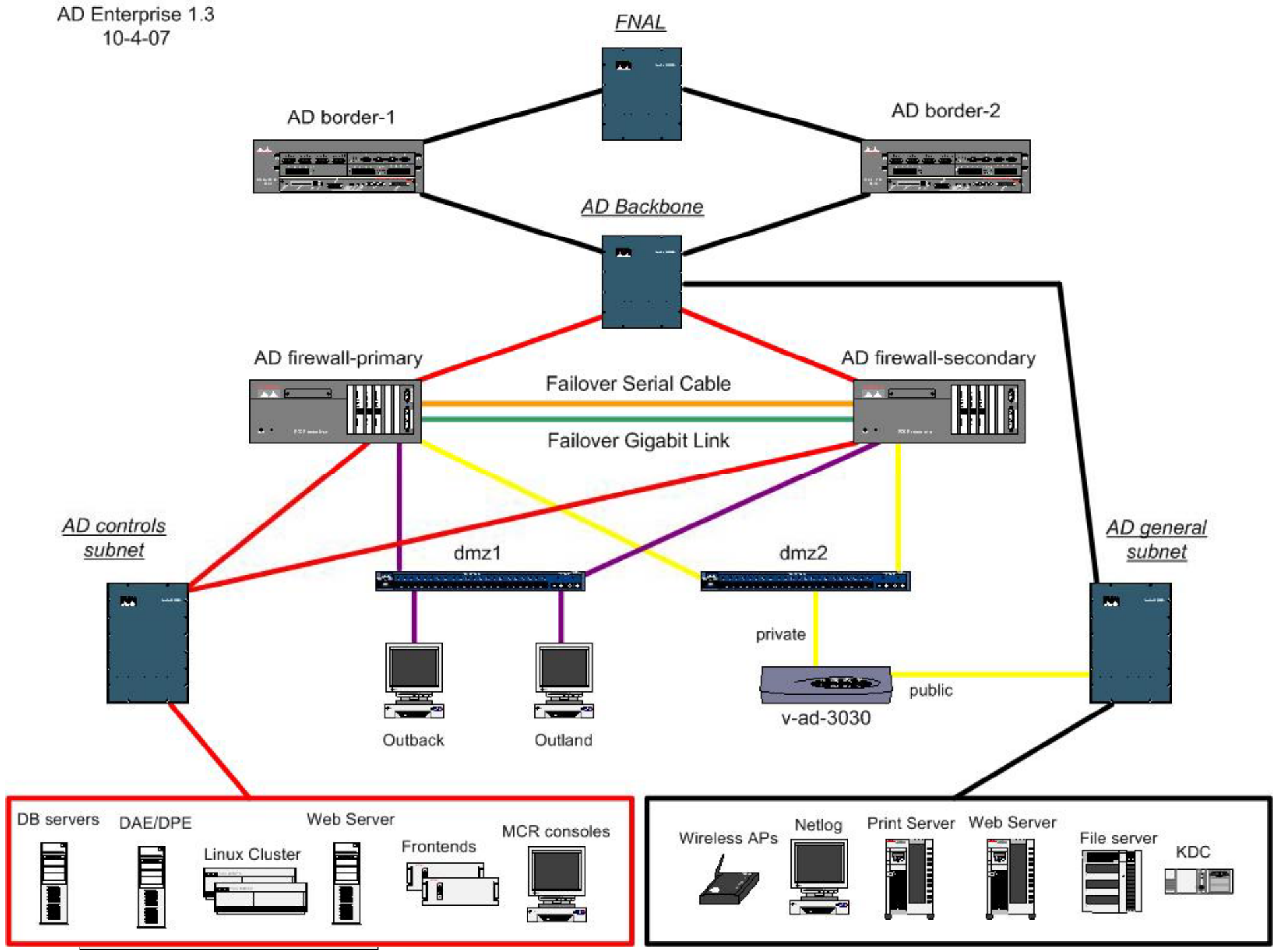
I. Overview

- An inventory of all systems (over 3,500 in the control system alone) on the network is maintained, including: OS and hardware, location, sysadmin, primary user

- Automated notification reports any changes to registered IP and MAC addresses on the network

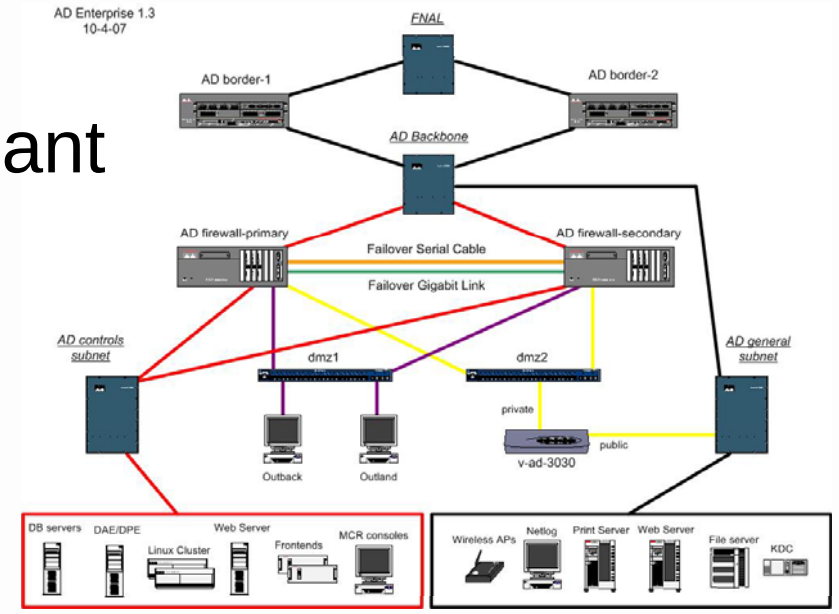
I. Overview

- Accelerator configuration is stored 4 times a day, and on demand. This allows return of the accelerator to a known state:
  - » After testing new machine configurations
  - » After replacing or adding new equipment
  - » After scheduled downtime and power outages
- Tape backups are done daily and tapes are moved to another area on a regular schedule


AD Enterprise 1.3
10-4-07
FNAL
AD border-1
AD border-2
AD Backbone
AD firewall-primary
AD firewall-secondary
Failover Serial Cable
Failover Gigabit Link
AD controls subnet
dmz1
dmz2
AD general subnet
private
public
v-ad-3030
Outback
Outland
DB servers
DAE/DPE
Web Server
Linux Cluster
Frontends
MCR consoles
Wireless APs
Netlog
Print Server
Web Server
File server
KDC

I. Network Layout Overview

- Control system nodes are isolated behind the redundant firewalls
- Firewalls pass selected traffic only (default deny) inbound and outbound



- VPN and Bastion hosts in DMZ allow authenticated traffic through the firewall
- Emergency disconnect at division routers

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II. Balancing Risks vs. Usability

- Reducing disruption to operations by cyber threats is important, ***however*****,** reducing disruption to operations by cyber protections is also ***very*** important!

- More accelerator downtime due to effects of cyber protection than from cyber attacks

II. Cyber Risks

- No ‘secret’ information
- Equipment designed to be safe at any control setting
- Lab is a ‘high profile’, ‘government’ target
- So, risks are disruption of operations and embarrassment, not leaks of sensitive data nor fear of equipment damage

II. Usability

- Accelerator systems are constantly being improved, adjusted and maintained by a large group of Physicists, Engineers, Computer Professionals and others

- Accelerator systems are often monitored and problems diagnosed by experts from locations other than the Main Control Room

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III. Network Layer Protection

- Accelerator Division border disconnect
  - » Emergency disconnect from the world
- Border router Access Control Lists
  - » Protect entire Division and PIX firewalls
- Redundant Cisco PIX firewalls **(outbound)**
  - » Traffic allowed to many on-site resources
  - » No email access, No windows remote desktop

III. Network Layer Protection

- Redundant Cisco PIX Firewalls **(inbound)**
  - » Full default deny
    - Offsite access to 5 specific nodes/services
    - Onsite access to kerberized services (MIT and W2K) and a few tightly maintained application services
    - Accelerator Division hardwired desktop systems access to several more specific protocols
- Controls Router Access Control Lists
  - » Isolate controls Vlans from each other

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IV. OS/Application Layer Protection

- Linux systems use Site autoYUM service for OS and Applications and Site MIT Kerberos
- Windows systems use Division patching services and Site W2K Domain, plus Control System Anti-Virus service
- FreeBSD and Solaris systems use ‘portaudit’ and vendor email notification – these systems have ‘professional’ administrators

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V. Access Options

- **VPN**
  - » Software client, controls ‘key’ & login required
  - » Authenticated & time limited network access
  - » Remote system becomes a ‘Controls’ node
  - » Full inbound and outbound firewall restrictions apply (no ‘split tunnel’) all traffic is ‘inside’
  - » Still requires further login to get command line access or to start a control system console

V. Access Options

- **Bastion Hosts**
  - » Two redundant nodes with minimal services
  - » MIT Kerberized login (or Cryptocard token)
  - » Time limited logins
  - » SSH port forwarding allowed for X11 and other protocols
  - » NFS mounts of inside disk to allow kerberized FTP access (FTP is otherwise blocked at FW)

V. Access Options

- **Windows Remote Desktop**
  - » Terminal server on Division network for email and offsite web access from inside systems
  - » Terminal server on Controls network for access to web and other services inside (scopes, etc) from Onsite network systems
  - » TS nodes disallow file xfer and drag-n-drop
  - » All other inbound/outbound WRD is blocked

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VI. Future Directions

- Site LDAP service to centralize authentication for non-kerberized services
- SSL and KX509 Client Certificates for some web pages (logbooks, etc.)
- Better integration of Apple OS X systems
  - » Include in MIT Kerberos
  - » Include in anti-virus and auto patching


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