Group 3 Homework #2: Data Center Tour Report

Kevin Yomba, Legendre Cooper, Nathan Ketterlinus, Owen Segala, and Preet Chodavadia

Towson University

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Yeong-Tae Song

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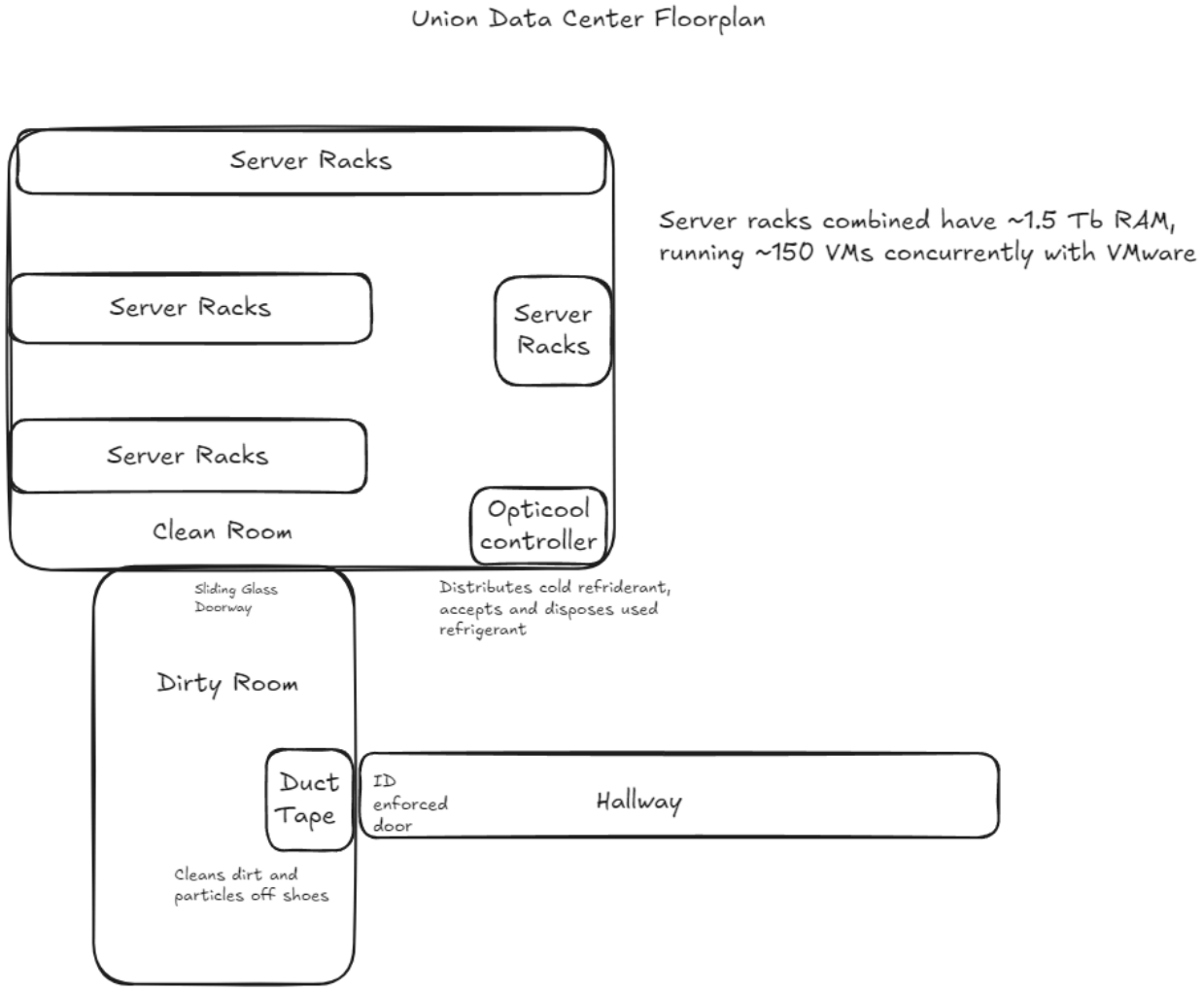
General Summary of Notes Taken

- General Information
    - Towson's newer, upgraded data center is the main one, complemented by the Cook Data Center, which serves as its "little sister."
    - Built in 2021, it supplies half the computing power for the campus, with both data centers operating in a Layer 2 adjacent setup, allowing them to function as though they are in the same room.
- Connectivity
    - Every campus building has a dedicated data hub connected to both data centers via underground fiber.
    - Distribution switches connect these hubs to the centers, with RGA45 copper Ethernet used within hub rooms.
    - The campus network supports up to 20Gbps total bandwidth, split across two 10Gbps uplinks.
- Network Structure
    - The network operates in three layers:
        - **Access Layer**: Hub rooms in buildings.
        - **Distribution Layer**: Centralized building connections.
        - **Core Layer**: The data centers themselves.
    - Redundancy ensures minimal downtime; if one data center fails, the other can run at 10Gbps.
- Hardware and Storage

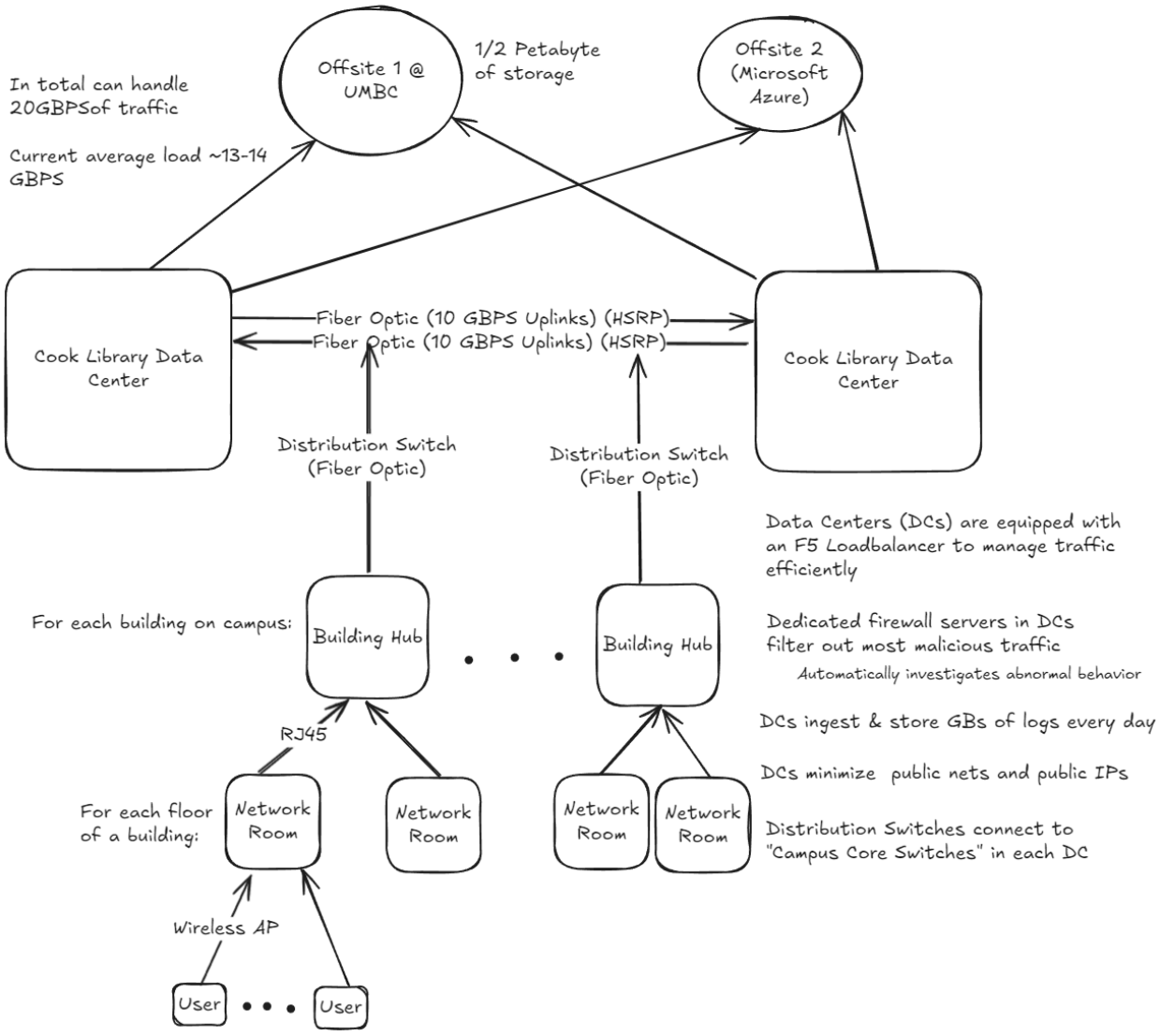
    - Central computing hardware consists of four racks of servers with 1.5TB of RAM, supporting ~150 virtual machines (VMs).
    - VMware virtualization is being phased out in favor of Microsoft's VM platform.
    - The data center handles large data volumes, ingesting and storing gigabytes of logs daily.
    - UMBC serves as the backup location with 0.5 petabytes of storage available.
- Security
    - All campus devices require MAC address registration.
    - Abnormal bandwidth usage triggers automatic investigations.
    - The network minimizes public-facing IPs and relies on dedicated firewall servers.
    - F5 load balancers in each data center distribute traffic and add a layer of security.
- Cooling and Power
    - Two cooling systems maintain the hardware:
        - **Ambient Cooling** for general temperature management.
        - **OptiCool In-Rack Cooling**, using a chilled water system to exchange heat.
    - Cook Data Center relies on traditional room cooling without OptiCool.
    - The physical plant manages costs for electric and cooling infrastructure.
- Disaster Management
    - Non-water chemical fire suppression is the primary safety system.
    - As a fallback, sprinklers and a soap-based system activate, though these can damage hardware.
    - No fires have occurred in the data center to date.

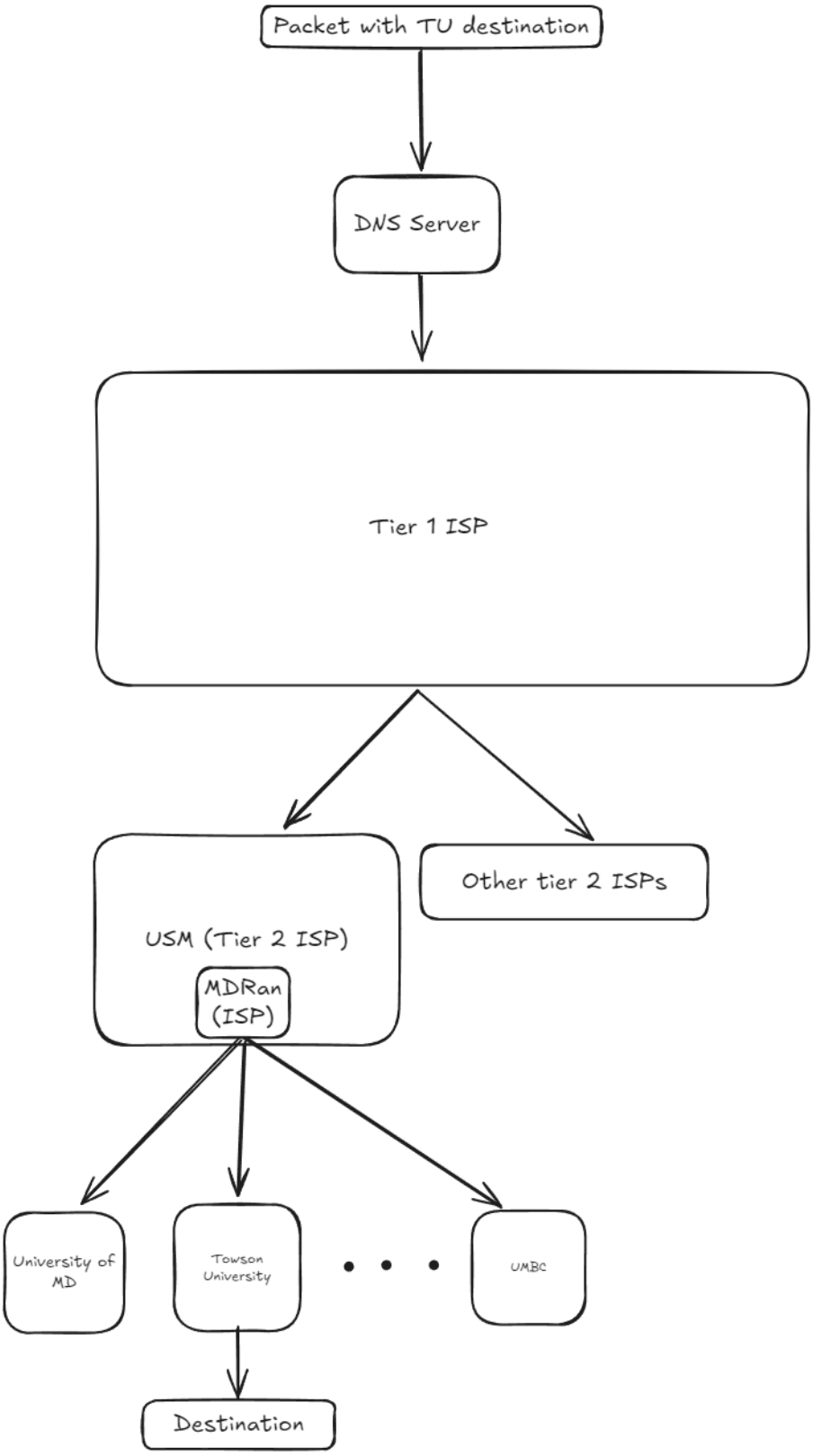
- Future Plans and Maintenance
    - Upgrades follow a six-year hardware replacement cycle, with planning extending 5–10 years ahead.
    - Services and infrastructure are moving to the cloud where possible, with critical systems backed up at offsite locations.
    - Annual building network upgrades occur each January, with communications sent to notify users of downtime.

Visual Information based on Notes



TU Network Architecture




Packet with TU destination
DNS Server
Tier 1 ISP
USM (Tier 2 ISP)
MDRan (ISP)
Other tier 2 ISPs
University of MD
Towson University
UMBC
Destination

Introduction

Towson University is one of the largest public universities in Maryland, hosting over 20,000 students attending and residing on and off-campus, as well as a number of staff. As with any large public university, Towson relies heavily on the Internet and its supporting technologies to enable its functions as a center of learning and career advancement. Particularly, Towson's networking technologies have much to do with the quantity and speed that the university systems can store, send, and receive data of all types. On Monday, November 18, students taking Data Communications and Networking under professor Yeong-Tae Song were given the privilege of taking an informative tour of one of the two primary on-site data centers handling the university's digital information load. Students were divided into groups dedicated to one of each of a number of topics related to the course–this group chose the "Networking Technologies". This report will cover several aspects of networking based on the information gained during the tour, those topics being: ethernet and cabling, network redundancy and failover, network security, wi-fi, data transmission and latency, network monitoring, cooling, and future-proofing and scalability.

Ethernet and Cabling

The secondary data center at Towson emphasizes robust Ethernet and cabling solutions to ensure reliable network connectivity across the campus. All buildings connect to the data centers via underground fiber optics, with every building featuring a dedicated network hub room. These hubs link to the data centers through distribution switches, ensuring consistent high-speed access via RGA45 copper Ethernet cables. Each data hub has dual connections to both data centers, enhancing network reliability and throughput.

Network Redundancy and Failover

Redundancy is a cornerstone of the data center's design, providing seamless failover capabilities. If one data center experiences a failure, the other can sustain campus operations at up to 10Gbps speed. This setup minimizes service disruption, with systems like SQL databases designed with high redundancy. Critical services also utilize offsite backups hosted on Microsoft Azure and the University of Maryland, Baltimore County (UMBC), further strengthening disaster recovery options.

Network Security

Towson's network security strategy includes multiple layers of defense. All devices connecting to the network require MAC address registration, and abnormal bandwidth usage triggers automatic investigations. Dedicated firewall servers protect the campus's data, while public-facing IPs are minimized to reduce exposure. The "F5" load balancers, one at each data center, provide not only traffic distribution but also function as advanced security devices to handle potentially malicious traffic.

Wi-Fi

The campus Wi-Fi network benefits from the robust infrastructure provided by the secondary data center. Each building’s network hub connects directly to both data centers, ensuring stable and high-speed wireless coverage across the campus. With a central distribution network in place, bandwidth flexibility and optimal usage are maintained, even during peak periods.

Data Transmission and Latency

Towson's secondary data center supports a campus-wide network with a total bandwidth capacity of 20Gbps, split across two 10 Gbps uplinks. This high-capacity setup ensures minimal latency and efficient data transmission. The Layer 2 network architecture allows the data centers to function as though they are in the same physical location, enhancing performance and reducing delay.

Network Monitoring

Monitoring is a continuous process, with monthly architecture reviews and audits conducted to ensure optimal performance. The data center ingests gigabytes of logs daily, helping to identify and address potential issues quickly. Abnormal traffic or bandwidth consumption is flagged for immediate investigation, ensuring network reliability and security.

Cooling

The data center utilizes advanced cooling systems, including in-rack cooling (OptiCool) and ambient air systems, to maintain optimal operating temperatures. The OptiCool system uses a chilled water refrigerant line to exchange heat with the server racks. These efficient cooling solutions are critical for preventing overheating, as the hardware generates significant heat proportional to the power used.

Future-Proofing and Scalability

Planning for future upgrades is integral to Towson’s strategy. The data center hardware undergoes a replacement cycle every six years, and plans for upgrades extend 5–10 years ahead. As technology evolves, the center is transitioning from VMware to Microsoft's virtualization

software and is increasingly shifting workloads to the cloud. This approach ensures scalability and keeps the infrastructure aligned with modern demands.