ITMO 540

Introduction to Data Networks and the Internet

Final Project Report

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COMPANY OVERVIEW

Chicago Hospitality Management Group, Inc. (CHMG) is a company that owns real estate, taverns (a.k.a. bars, nightclubs, etc.) and restaurants across Chicagoland. The company is privately held by a small group of owners. CHMG owns four properties in Chicago and leases space in two other buildings. Their locations are as follows:

Location Name	ID	Address	Use	Ownership
The Bronzeville Club	3501	3501 S. Michigan Ave.	Nightclub, apartments, commercial rental & corp. office	Owned
Bridgeport Bites	3150	3150 S. Halsted St.	Restaurant	Owned
Ravenswood Manor	4989	4989 N. Rockwell St.	Apartments	Owned
Lakeview Tap	3570	3570 N. Clark St.	Tavern	Leased
Andersonville Bar	5035	5035 N. Clark St.	Tavern, commercial rental space & apartment	Owned
Edgewater Tavern	6398	6398 N Broadway	Tavern	Leased

In order to design and implement the best communication infrastructure to support their operations, CHMG hired you as their first IT manager. Congratulations on your new career! They are now anxiously awaiting your design to start ordering internet service, hardware, and software to implement everything and get their locations running.

The main deliverable is a detailed infrastructure design that includes all components and presents a 3-year Total Cost of Ownership (TCO) to CHMG.

COMPANY LOCATIONS

3501: 3501 S. Michigan Ave.

The Bronzeville location was built in 1895 as a 3-story hotel plus basement. Over the years it was remodeled into commercial space and apartments. The Chicago Hospitality Management Group (CHMG) recently acquired the building along with the night club that occupies the first floor and basement on the south half of the building. There is an existing retail tenant on the first floor and basement in the north half of the building as well as apartments on the second and third floors. CHMG will be remodeling two of the vacant apartments on the third floor as their new corporate offices as well as updating the night club to fit their needs.

The personnel based in the office include:

- 2 CHMG owners (President/CFO and Vice-President/General Counsel)
- 1 Accounting and procurement manager
- 1 Director of operations
- 3 Marketing staff members

- 1 Audio-visual content producer
- 1 Event producer
- 1 Facilities manager
- 2 "hoteling" desks for other team managers

There is space designated to be the main IT room on the first floor of the night club that can service the entire building. In addition, there is a small closet inside the corporate office that can be used for additional IT space or an IDF if needed. The owners wish to provide wireless internet service for their residential tenants, along with a limited number of wired ethernet jacks for each tenant, one for the TV in the living room, and one in each bedroom. In addition, they desire an IP door phone outside the apartment entrance to allow guests to call the tenants and corporate office staff. For the commercial (retail) tenant, the owners wish to provide wireless internet service, along with a limited number of wired ethernet jacks. You may place these on the design wherever you desire.

3150: 3150 S. Halsted St.

CHMG purchased a storefront in Bridgeport to open their new restaurant concept of Korean Tapas. The restaurant seats 104 customers and will have 4 servers, 2 busboys, 4 kitchen staff, a dishwasher, a bartender and host working at any given time. All customer orders will be entered onto the Toast wireless handhelds except bar orders which will be entered onto the wired point of sale terminal. There are two printers in the kitchen for orders, a terminal and printer at the bar to print customer receipts, and a terminal and printer at each of the service stations for the servers to print customer receipts. There is also a POS terminal at the host stand to track reservations. The IT and AV equipment for this location should be placed in the office.

4989: 4989 N. Rockwell St.

The owners of CHMG have purchased a four-story apartment building in the Ravenswood neighborhood on a quiet residential street. This building will be an investment property for them and be rented to four tenants.

They wish to provide wireless internet service for their tenants, along with a limited number of wired ethernet jacks for each tenant, one for the TV in the living room, and two in the den on each floor. In addition, they desire an IP door phone to allow guests to call the tenants. Finally, there will be four IP based security cameras on the four corners of the building at the first floor to be provided by others. The cabling and ethernet ports shall be a part of your design, however.

The IT equipment for this location should be placed in the small room inside the back door on the first floor (the center left of the drawing below).

3570: 3570 N. Clark St.

The Lakeview Tap is a small neighborhood bar on the first floor of a 20-year leased space on a busy commercial street near Wrigley Field. They are open late nights.

The IT and AV equipment for this location should be placed in the office.

5035: 5035 N. Clark St.

This building was purchased by CHMG and remodeled into multiple spaces.

Andersonville Bar is owned by CHMG and will occupy the first floor and second floors of the west side of the building along with the west part of the basement for non-customer use. In the basement are storage spaces, an office, and a reasonably sized IT room.

Doug's Pizza Parlor has signed a 15-year lease for the east part of the first floor and basement kitchen space.

The east side of the second floor is a small studio apartment. The owners wish to provide wireless internet service for the tenant, along with a limited number of wired ethernet jacks for each tenant, one for the TV in the living room, and two in the kitchen. In addition, they desire an IP door phone outside to allow guests to call the tenant.

For the commercial (retail) tenant, the owners wish to provide wireless internet service, along with a limited number of wired ethernet jacks. You may place these on the design wherever you desire.

6398: 6398 N Broadway

The Edgewater Tavern is a popular neighborhood bar located near the Loyola Campus and occupies the first floor of a 10-year leased space at a buy intersection near Broadway and Devon in Edgewater. They offer a variety of programming and entertainment that draws capacity crowds on Friday nights, Saturdays, and Sundays. In the summer months, the rear patio is often filled to capacity on Weekends.

The first floor and patio are customer spaces. The basement is storage, coolers, and office space. IT equipment should be located near the office area.
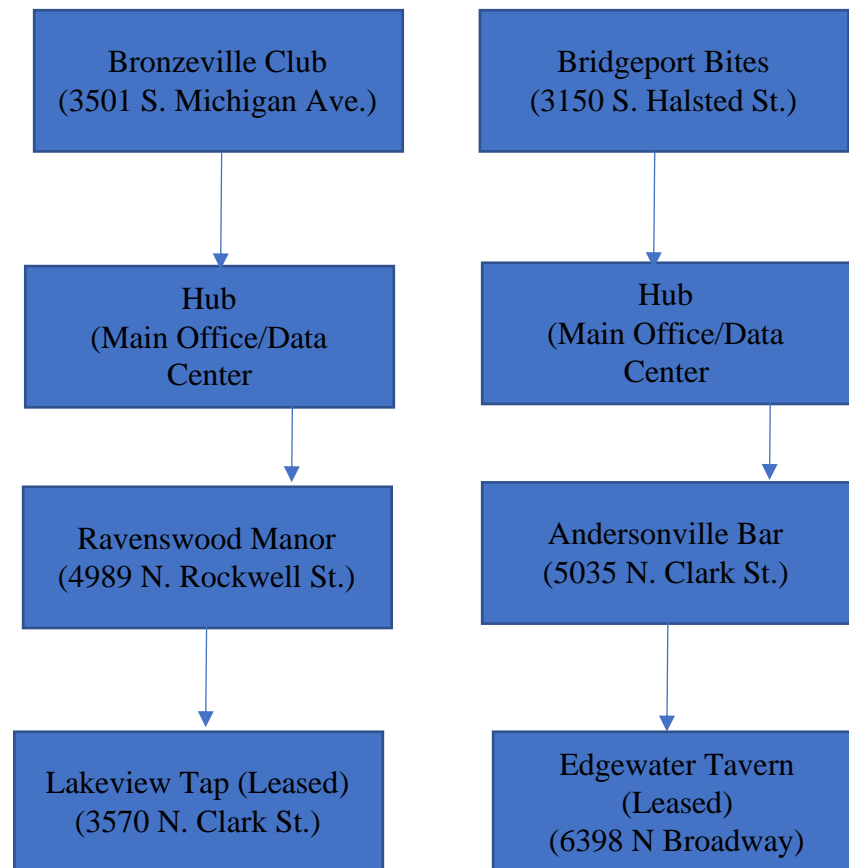
DESIGN ELEMENTS

1. Wide Area Network Infrastructure
    a. WAN Technology selected.
        i. The VPN-based WAN solution means secure connectivity between the various CHMG office locations that brings in reliable connectivity to POS systems and automation, while also optimally using capital and operating costs through the already-paid-for internet connections. The solution can scale to fit the growth and change of the company's network requirement over time.

    b. Logical diagram.

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┌─────────────────────┐        ┌─────────────────────┐
│  Bronzeville Club    │        │  Bridgeport Bites    │
│ (3501 S. Michigan Ave.)│      │ (3150 S. Halsted St.) │
└─────────────────────┘        └─────────────────────┘
           │                              │
           ▼                              ▼
┌─────────────────────┐        ┌─────────────────────┐
│        Hub          │        │        Hub          │
│ (Main Office/Data    │        │ (Main Office/Data    │
│      Center          │        │      Center          │
└─────────────────────┘        └─────────────────────┘
           │                              │
           ▼                              ▼
┌─────────────────────┐        ┌─────────────────────┐
│  Ravenswood Manor    │        │  Andersonville Bar   │
│ (4989 N. Rockwell St.)│       │ (5035 N. Clark St.)  │
└─────────────────────┘        └─────────────────────┘
           │                              │
           ▼                              ▼
┌─────────────────────┐        ┌─────────────────────┐
│ Lakeview Tap (Leased)│        │  Edgewater Tavern    │
│ (3570 N. Clark St.)  │        │     (Leased)         │
│                      │        │ (6398 N Broadway)    │
└─────────────────────┘        └─────────────────────┘
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Hub: Represents the main office or data center where the VPN concentrator/router is located.
Bronzeville Club, Bridgeport Bites, Ravenswood Manor, and Andersonville Bar: These locations are connected to the central hub via site-to-site VPN tunnels over the internet.

Lakeview Tap and Edgewater Tavern: Although these locations are leased, they are also connected securely to the main hub using VPN technology.

c. Router specification.

Ubiquiti EdgeRouter series, specifically the **Ubiquiti EdgeRouter Lite (ERLite-3)**
- With such a high competitive level in the price, the Ubiquiti routers are much more seductive than most other routers at the enterprise level for controlling costs by a business.
- The EdgeRouter Lite (ERLite-3) and EdgeRouter 4 (ER-4) offer good performance for small to medium networks and are pretty capable in hardware, especially in VPN and routing functionality.
- They both support VPN with IPsec, OpenVPN, or PPTP for site-to-site or remote access connectivity, which is a must for all locations where secure connections have to be established.
- Designed with advanced routing features, support VLANs, quality of service (QoS) controls, and firewall capabilities, which enable very flexible network configuration with security.
- These routers support scaling and increased network demands and are appropriate for growing businesses or additional site deployment.
- Ubiquiti offers an easy-to-use web interface (Ubiquiti Network Management System - UNMS) that centralizes the management and monitoring of EdgeRouter devices, making network administration easier.

d. Equipment list and pricing.

Equipment List:
1. **Ubiquiti EdgeRouter 4 (ER-4)**:
   - Enterprise-class router with Gigabit Ethernet ports, hardware acceleration, and robust routing capabilities.
   - **Estimated Price**: Approximately $199 - $249 per unit.
2. **Ubiquiti EdgeRouter Lite (ERLite-3)**:
   - Compact router suitable for smaller deployments, offering Gigabit Ethernet ports and VPN support.
   - **Estimated Price**: Approximately $99 - $129 per unit.
3. **Ethernet Cables**:
   - Category 6 (Cat6) Ethernet cables for connecting routers to network devices (lengths as needed).
   - **Estimated Price**: Varies based on length and quantity; budget around $1 - $2 per foot.
4. **Power Over Ethernet (PoE) Adapter** (if applicable):

- Ubiquiti PoE adapters for providing power to compatible devices such as access points or IP cameras.
- **Estimated Price**: Around $15 - $30 per adapter

Estimated Total Cost:

To estimate the total cost for setting up the WAN infrastructure using Ubiquiti EdgeRouter routers, consider the following hypothetical scenario based on CHMG's needs:

- **Main Office/Hub**: Ubiquiti EdgeRouter 4 (ER-4) - 1 unit
  - **Estimated Cost**: $199 - $249
- **Branch Offices/Locations**: Ubiquiti EdgeRouter Lite (ERLite-3) - 4 units (for Bronzeville Club, Bridgeport Bites, Ravenswood Manor, Andersonville Bar)
  - **Estimated Cost**: $99 - $129 per unit $\times$ 4 = $396 - $516
- **Additional Components**:
  - Ethernet Cables, PoE Adapters, Accessories, etc.
  - **Estimated Cost**: Varies based on specific requirements and quantities.

Total Estimated Budget Range:

- **Low-End Estimate**:
  - EdgeRouter 4 (Hub) + EdgeRouter Lite (Branches) = $199 (ERLite-3) + ($99 - $129) $\times$ 4 = $595 - $715
- **Mid-Range Estimate**:
  - EdgeRouter 4 (Hub) + EdgeRouter Lite (Branches) = $249 (ER-4) + ($99 - $129) $\times$ 4 = $645 - $765
- **High-End Estimate**:
  - EdgeRouter 4 (Hub) + EdgeRouter Lite (Branches) = $249 (ER-4) + ($129) $\times$ 4 = $745

e. Telecommunication facility (WAN links) specification and pricing.

- **Primary WAN Link**: Internet VPN for cost-efficiency and adequate performance.
  - **Estimated Cost**: $50 - $500+ per month based on bandwidth requirements.
- **Backup/Failover Link**: Consider a secondary link (e.g., MPLS, dedicated leased line) for redundancy and business continuity.
  - **Estimated Cost**: $200 - $2000+ per month depending on chosen backup link.

Total Estimated Budget:

The total estimated budget for WAN links will depend on specific requirements, desired bandwidth, and geographic coverage. As a rough estimate:

- **Low-End Estimate**: Starting from $50 - $250 per month for primary internet VPN link.

- **Mid-Range Estimate**: Budgeting $250 - $1500+ per month for primary internet VPN plus backup link.
- **High-End Estimate**: Higher budgets exceeding $1500 per month for robust MPLS or dedicated leased line solutions.

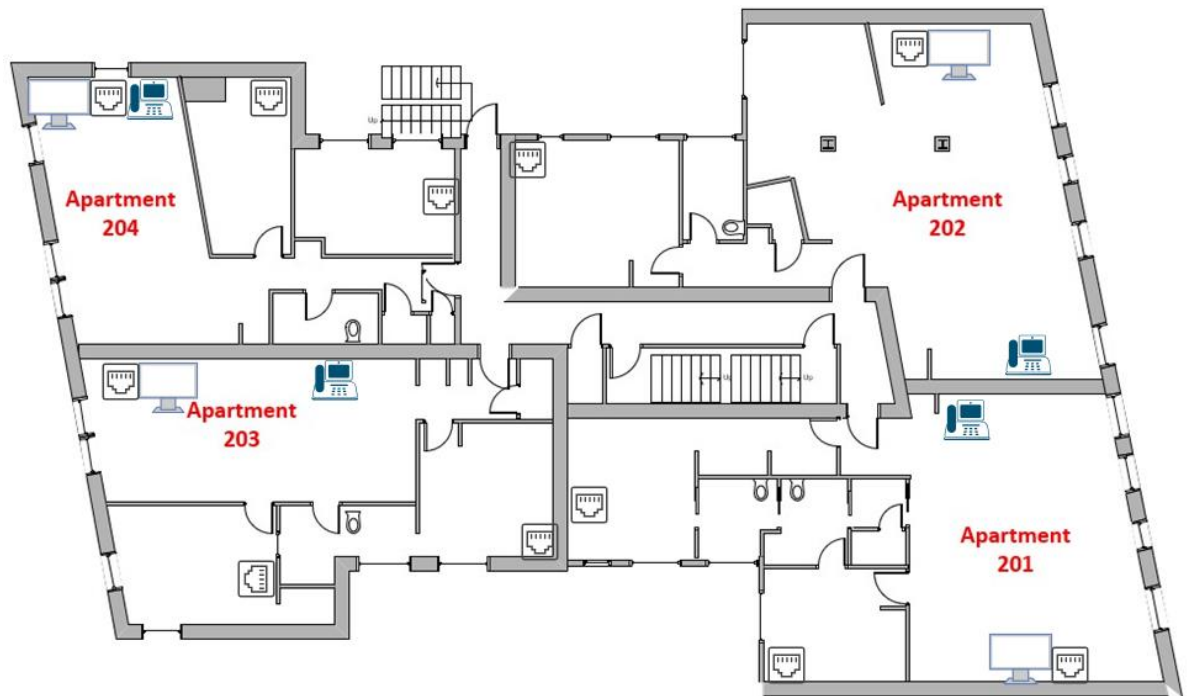2. Network Infrastructure for all six locations.
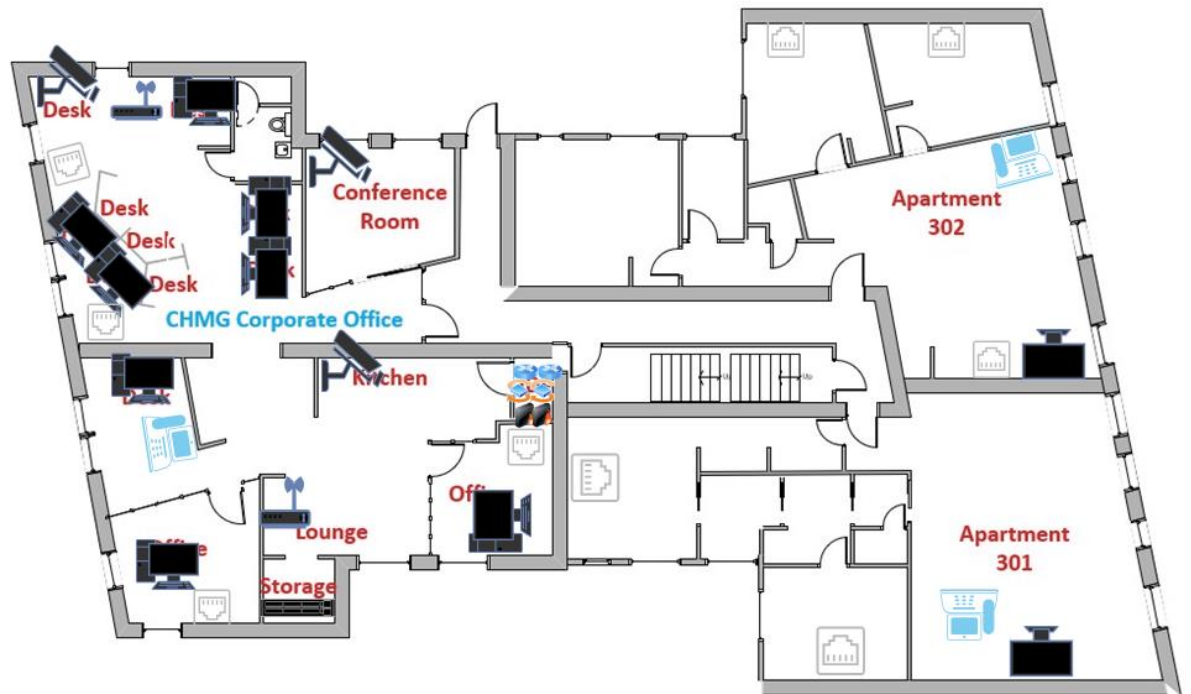   Physical layout and diagram.

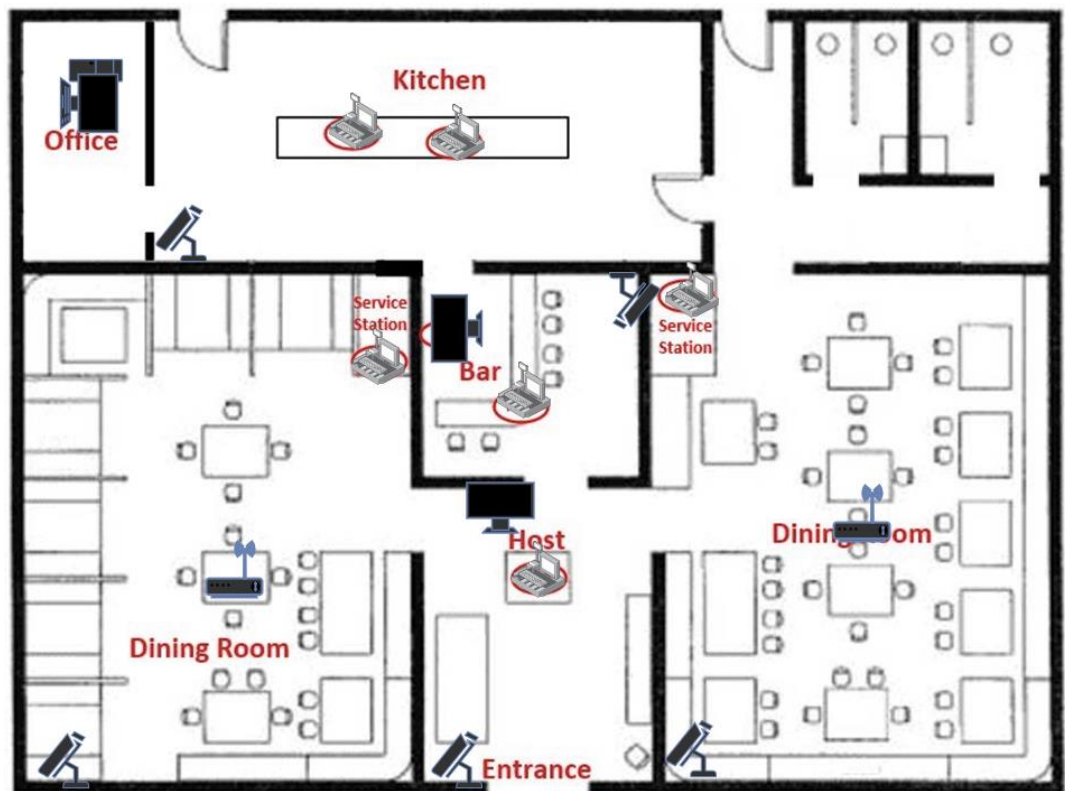**1.3501 Basement**
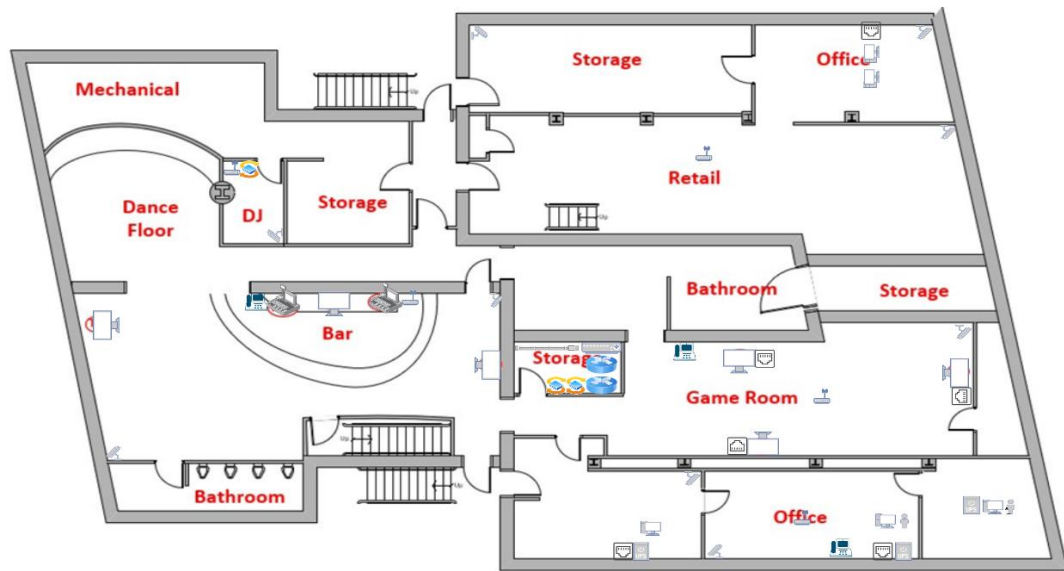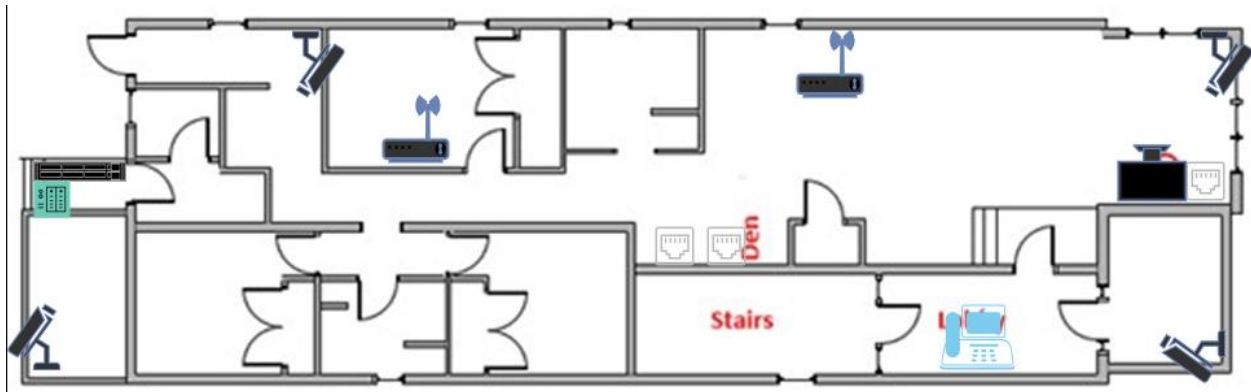
2.3501 First Floor
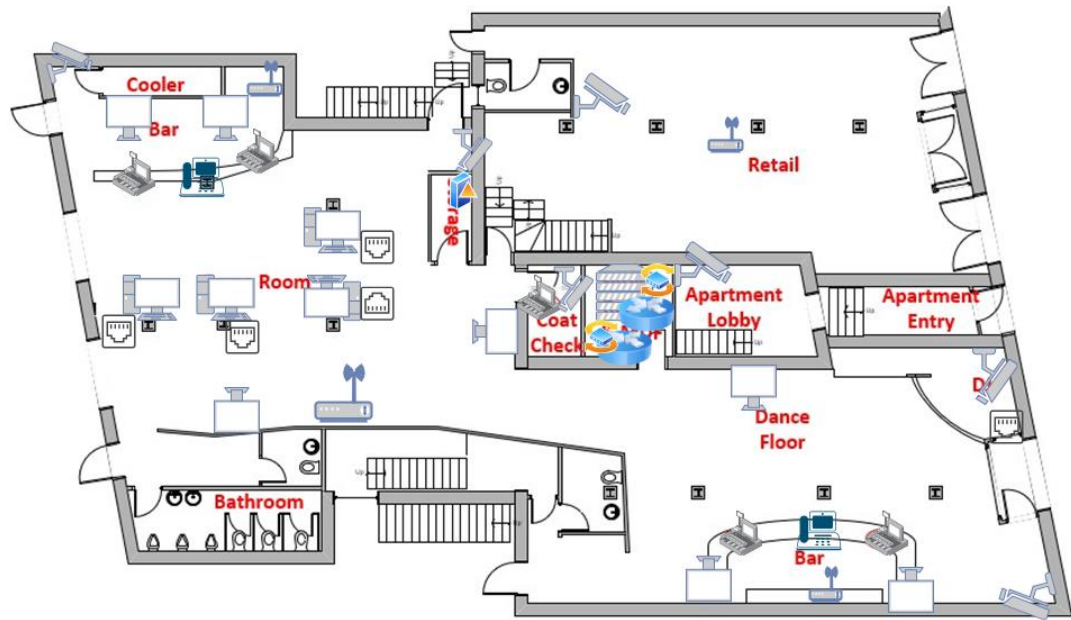
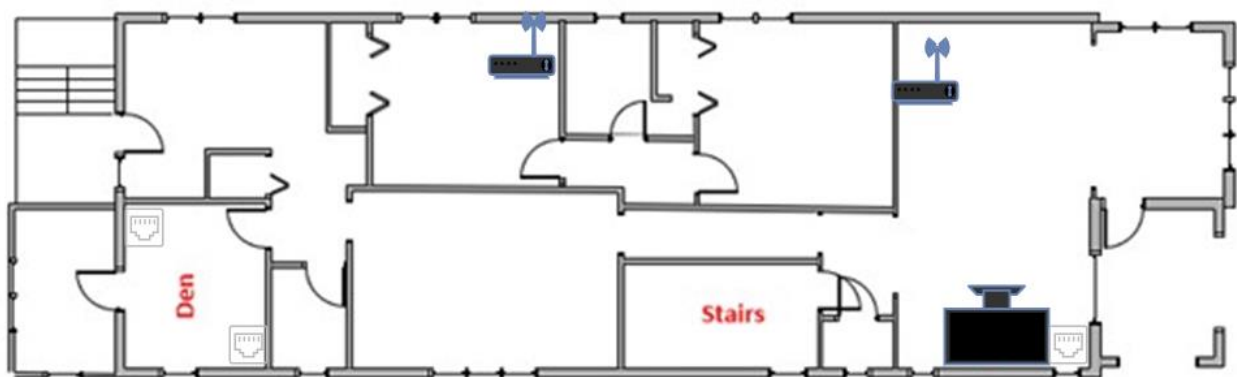## 3.3501 Second Floor

4.3501 Third Floor
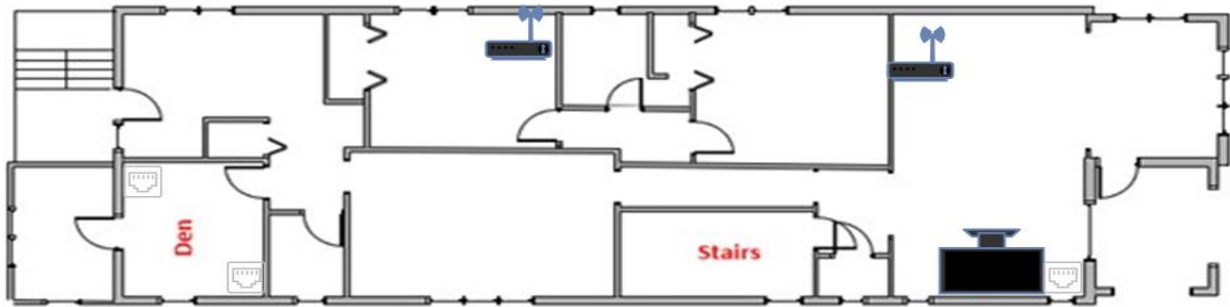

3150 Restaurant

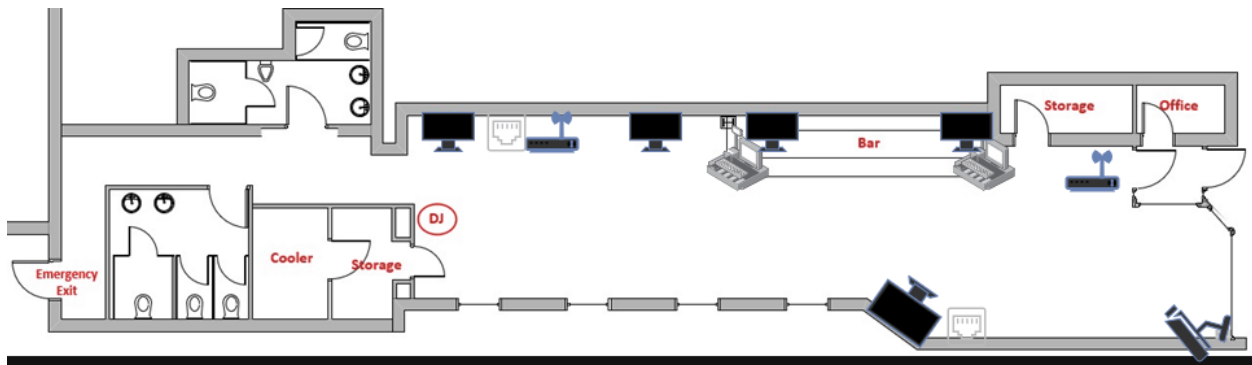**4989 First Floor**

4989 Second Floor
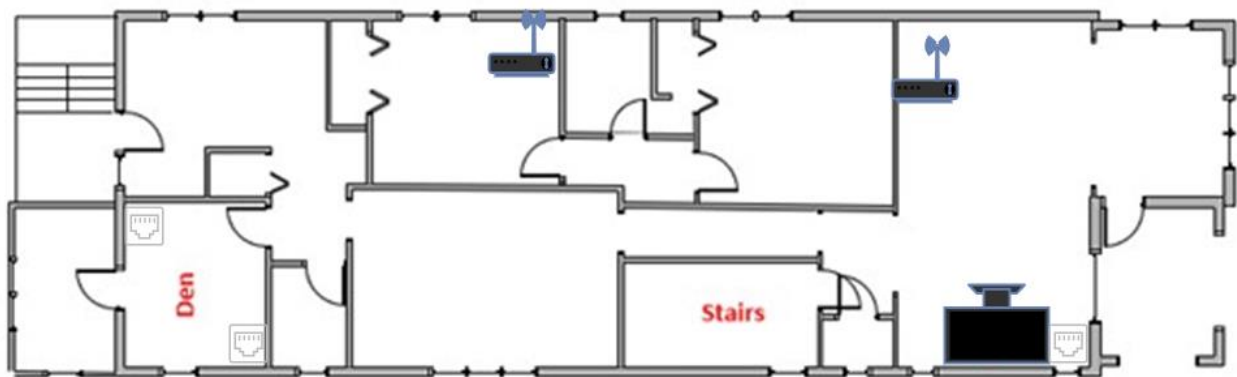
4989 Third Floor

4989 Fourth Floor

3570

5035 Basement

5035 First Floor

5035 Second Floor

Game Room • Restroom • Restroom • Roof Deck • Apartment • Kitchen • Restroom

6398 Basement

Storage • Storage • Office • Cooler • Storage

6398 First Floor

Bar • Outdoor Patio • Bathrooms • Bar • Storage
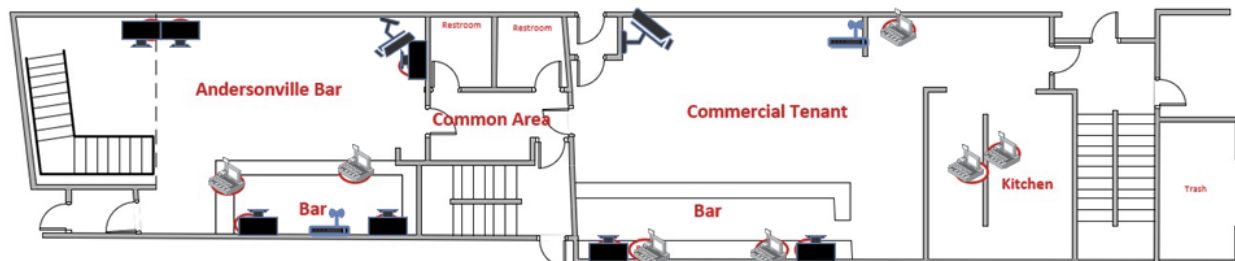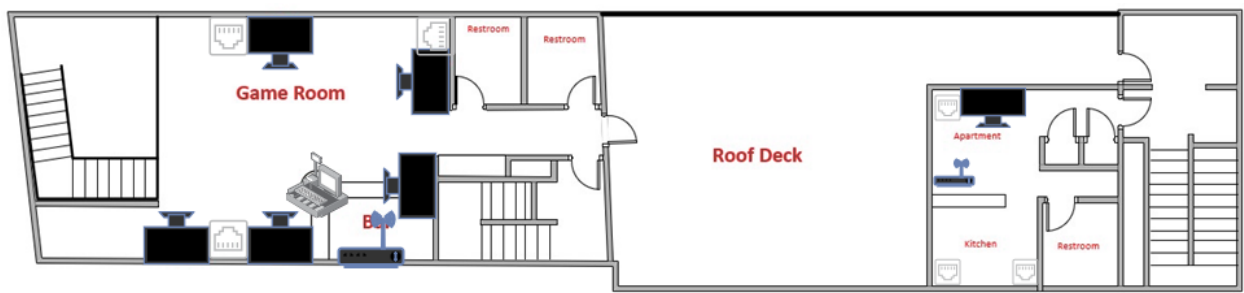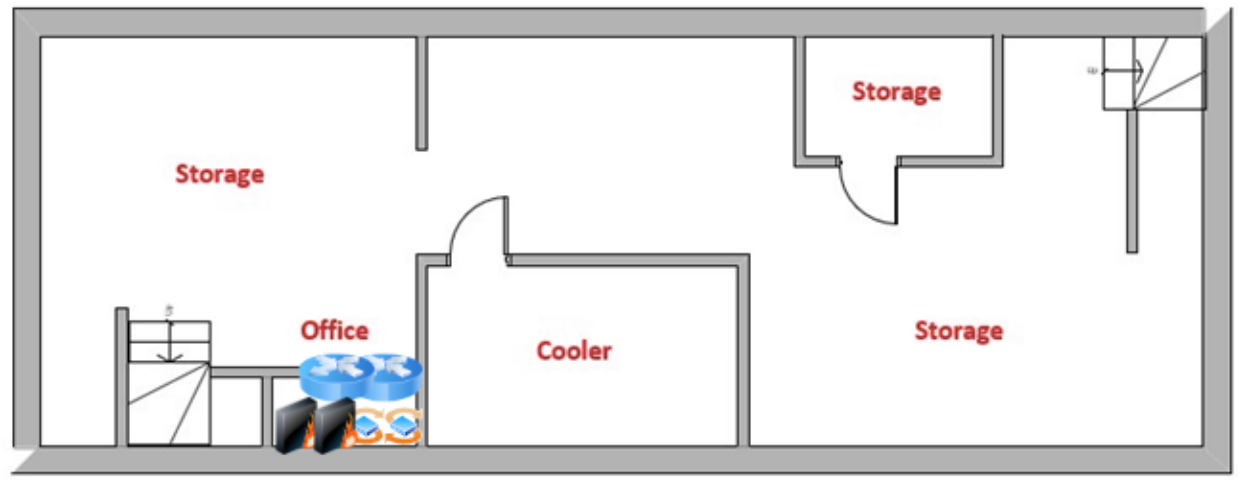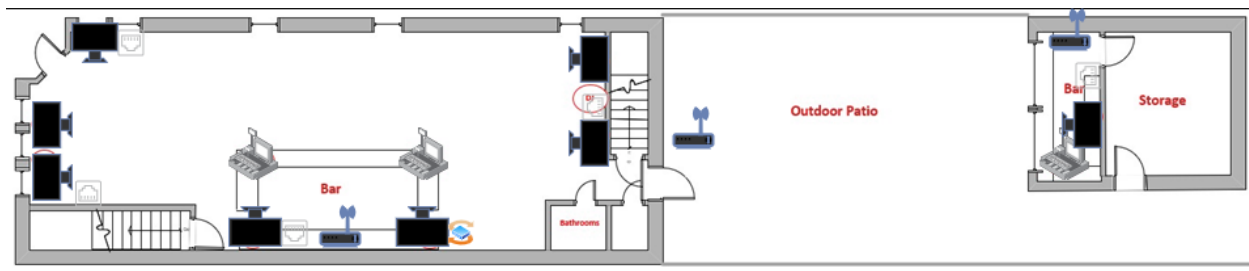
Equipment list and pricing.

1. **Point of Sale (POS) Terminals** (25 units):
   - **Monthly Subscription**: Toast POS at $69 per terminal per month.
   - **Total Monthly Cost**: $69 per terminal × 25 terminals = **1,725 per month**.
2. **Wi-Fi Routers** (33 units):
   - **Equipment**: Ubiquiti UniFi Wireless Access Points (WAPs) or similar enterprise-grade routers.
   - **Estimated Price**:
     - Ubiquiti UniFi AC Pro Access Point: $150 - $200 per unit.
   - **Total Estimated Cost**:
     - $150 - $200 per unit × 33 = **4,950 - $6,600** (one-time cost).
3. **Switches** (12 units) and **Routers** (10 units):
   - **Equipment**: Ubiquiti UniFi Switches and EdgeRouter Lite routers (or similar models).
   - **Estimated Price**:
     - Ubiquiti UniFi 24-Port Managed Switch: $250 - $350 per unit.
     - Ubiquiti EdgeRouter Lite: $99 - $129 per unit.
   - **Total Estimated Cost**:
     - Switches: $250 - $350 per unit × 12 = **3,000 - $4,200** (one-time cost).
     - Routers: $99 - $129 per unit × 10 = **990 - $1,290** (one-time cost).
4. **IP Phones** (15 units):
   - **Equipment**: Yealink or Cisco VoIP phones (compatible with VoIP service provider).
   - **Estimated Price**:
     - Yealink T46S IP Phone: $150 - $200 per unit.
   - **Total Estimated Cost**:
     - $150 - $200 per unit × 15 = **2,250 - $3,000** (one-time cost).

   Overall Estimated Budget:
- **Total Monthly Subscription Cost for POS**: $1,725 per month (based on Toast POS subscription).
- **Total Estimated One-Time Cost for Equipment**:
  - Wi-Fi Routers: $4,950 - $6,600
  - Switches and Routers: $3,000 - $4,200 (switches) + $990 - $1,290 (routers)
  - IP Phones: $2,250 - $3,000
- **Grand Total**:
  - **One-Time Equipment Cost**: $10,200 - $13,800
  - **Monthly Subscription Cost**: $1,725 per month (Toast POS).

IP address allocation for each location:

The Bronzeville Club:
Floor 1: VLAN 10 (192.168.1.0/24)
Floor 2: VLAN 20 (192.168.2.0/24)
Floor 3: VLAN 30 (192.168.3.0/24)
Basement: VLAN 40 (192.168.4.0/24)
Bridgeport Bites:
Floor 1: VLAN 50 (192.168.5.0/24)
Ravenswood Manor:
Floor 1: VLAN 90 (192.168.9.0/24)
Floor 2: VLAN 100 (192.168.10.0/24)
Floor 3: VLAN 110 (192.168.11.0/24)
Floor 4: VLAN 120 (192.168.12.0/24)
Lakeview Tap:
Floor 1: VLAN 130 (192.168.13.0/24)
Andersonville Bar:
Floor 1: VLAN 170 (192.168.17.0/24)
Floor 2: VLAN 180 (192.168.18.0/24)
Basement: VLAN 200 (192.168.20.0/24)
Edgewater Tavern:
Floor 1: VLAN 210 (192.168.21.0/24)
Basement: VLAN 240 (192.168.24.0/24)

Location 1: The Bronzeville Club
Internal Network Subnets:
- **Floor 1: 192.168.1.0/24**
- **Floor 2: 192.168.2.0/24**
- **Floor 3: 192.168.3.0/24**
- **Basement: 192.168.4.0/24**

Location 2: Bridgeport Bites
Internal Network Subnets:
- **Floor 1: 192.168.5.0/24**

Location 3: Ravenswood Manor
Internal Network Subnets:
- **Floor 1: 192.168.9.0/24**
- **Floor 2: 192.168.10.0/24**
- **Floor 3: 192.168.11.0/24**
- **Floor 4: 192.168.12.0/24**

Location 4: Lakeview Tap
Internal Network Subnets:
- **Floor 1: 192.168.13.0/24**

Location 5: Andersonville Bar
Internal Network Subnets:
- **Floor 1: 192.168.17.0/24**
- **Floor 2: 192.168.18.0/24**
- **Basement: 192.168.20.0/24**

Location 6: Edgewater Tavern
Internal Network Subnets:
- **Floor 1: 192.168.21.0/24**
- **Basement: 192.168.24.0/24**

Redundancy and Fault Tolerance CHMG Network: There should be different measures to be taken with redundancy and fault tolerance of the CHMG Network. In that case, the following measures should be taken, including dual routers with protocols as HSRP, stackable switches with EtherChannel to provide link redundancy, dual ISP connections with the Internet redundancy courtesy of BGP routing, UPS units for backup power, servers should be configured as redundant with clustering/load balancing, offsite backups, disaster recovery, network monitoring tools for proactive issue detection, and automated alerts for immediate notification of critical events.

Server Hardware and Licensing: CHMG should implement proven server hardware of sufficient capacity to underpin its applications. All models that the business uses must be licensed properly in order to comply with the licensing agreements required of all software vendors, and to be able to provide adequate support for the most critical systems.

Internet Connectivity - CHMG will be equipped with reliable internet connectivity featuring dual connections from the ISP, using BGP routing to ensure the redundancy will not require manual intervention.

Remote Access: Establish a secure remote access service for managerial staff based on the VPN technologies supported by Windows, Android, and iOS. Implement multi-factor authentication and encryption to ensure safe connections.

Authentication Systems: Implementing on-site Active Directory servers with redundancy provided by replication and, when necessary for authentication, using RADIUS. Use AD as the central authority for network authentication, enforcing security policies across CHMG's network.

Management in Security: Deploying several firewall appliances at remote sites prevents unauthorized access. Intrusion detection/prevention systems (IDS/IPS) can also be implemented to monitor and detect unauthorized activities. On the other hand, frequent updates of the security policies and vulnerability assessment on the network assures a continuous state of network security.

Network Management/Fault Management: Use network management tools to proactively monitor network performance and troubleshoot. Implement fault management practices including configuration of SNMP monitoring, syslog monitoring, automated alerting in the event of network faults.

Equipment Maintenance/Replacement Strategies: A detailed strategy on maintaining the equipment, starting from frequent inspections to updating the firmware and elimination of aged hardware components with the least possible downtime factor, for the reliability of the network to continue.

Data Security/Backup Strategies: Use data encryption for top priority information, back up critical data periodically to offsite locations, and map out a plan for disaster recovery to ensure that data is protected and available in case of a disaster.

Implementation plan: Implementation plan includes tasks, timelines, and resource requirements—such as staff needed for network infrastructure deployment. Thorough testing phases, user training, and contingency planning in case of unexpected challenges that can be experienced during deployment. Review and update the implementation plan on a regular basis based on feedback and evolving requirements.

Total Cost of Ownership
1. **Hardware Costs**:
   - Routers, Switches, Firewalls, Servers, Voice Systems, SANs/NASs, UPS, and other network devices:
     - Estimated Total Hardware Cost: $50,000 - $70,000
2. **Software Costs**:
   - Licensing for network equipment:
     - Estimated Total Software Cost: $10,000 - $15,000
3. **Maintenance Costs**:
   - Hardware replacement contracts, support contracts, software license maintenance:
     - Estimated Annual Maintenance Cost: $8,000 - $12,000 (Assuming 15% of hardware cost per year)
4. **Telecom Service Costs**:
   - Monthly telecom service costs (excluding internet access for home/remote users):
     - Estimated Annual Telecom Cost: $6,000 - $10,000 per year
5. **Implementation Costs**:

- Estimate tasks, hours required, and hourly rates for implementation:
  - Total Implementation Cost: Based on estimated hours and hourly rates (e.g., $50 - $150 per hour)
    - Example: If 200 hours are estimated for implementation at an average rate of $100/hour:

Total Implementation Cost = 200 hours × $100/hour = $20,000

Internet Access Costs (Per Month per Location):

- **Cable Internet Access (1 Gbps Download, 20 Mbps Upload):**
  - **Cost: $150.00 per month per location**
  - **Total Monthly Cost for 6 Locations: $150.00 × 6 = $900.00**

  Point-to-Point T1 Connection Costs (Per Month between Locations):
- **South Side to South Side Connection:**
  - **Cost: $500.00 per month**
- **North Side to North Side Connection:**
  - **Cost: $500.00 per month**
- **South Side to North Side Connection:**
  - **Cost: $650.00 per month**

  Total Monthly Costs for Point-to-Point T1 Connections (for 6 Locations):
- **South Side to South Side Connections: 2 connections**
  - **Total Monthly Cost: $500.00 × 2 = $1,000.00**
- **North Side to North Side Connections: 2 connections**
  - **Total Monthly Cost: $500.00 × 2 = $1,000.00**
- **South Side to North Side Connections: 2 connections**
  - **Total Monthly Cost: $650.00 × 2 = $1,300.00**

  Estimated Annual Costs (Based on Monthly Costs):
1. **Internet Access Cost (Cable Internet 1 Gbps):**
   - **Monthly Cost per Location: $150.00**
   - **Annual Cost per Location: $150.00 × 12 months = $1,800.00**
   - **Total Annual Cost for 6 Locations: $1,800.00 × 6 = $10,800.00**
2. **Point-to-Point T1 Connection Cost (Monthly Costs):**
   - **South Side to South Side Connections: $1,000.00**
   - **North Side to North Side Connections: $1,000.00**
   - **South Side to North Side Connections: $1,300.00**
   - **Total Monthly Cost for T1 Connections: $1,000.00 + $1,000.00 + $1,300.00 = $3,300.00**

   Total Monthly Costs (Internet + T1 Connections) for 6 Locations:
- **Internet Access Cost: $900.00 (Cable Internet)**
- **Point-to-Point T1 Connection Cost: $3,300.00**
- **Total Monthly Cost: $900.00 + $3,300.00 = $4,200.00**

  Total Annual Costs (Based on Monthly Costs):
- **Total Monthly Cost: $4,200.00**
- **Total Annual Cost: $4,200.00 × 12 months = $50,400.00**

  Total Cost of Ownership (TCO) Over 3 Years (Estimated):
- **Estimated TCO for 3 Years: $50,400.00 × 3 years = $151,200.00**