# ****Wi-Fi 6E Full-Campus Upgrade Proposal – triOS Kitchener Campus****

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## Executive Summary

This proposal presents a comprehensive wireless infrastructure upgrade plan for the triOS Kitchener Campus. The plan utilizes 16 enterprise-grade Wi‑Fi 6E access points (APs), advanced authentication and encryption protocols, VLAN segmentation, and roaming optimization technologies. It meets the growing demands of digital classrooms, BYOD, VoWi-Fi, and guest access with enhanced reliability, security, and scalability.

## Background and Strategic Justification

The current network infrastructure was deployed in 2013 using legacy Wi‑Fi 4 (802.11n) technology and is no longer sufficient. Problems include:

**◈ Student needs are evolving**: Over 76% of students use 2+ devices; cloud labs, streaming, and live quizzes are now standard in class.

**◈ Legacy hardware is at end-of-life**: 5×Cisco WAP 561 (Wi-Fi 4, deployed in 2013) with unsupported firmware and no WPA3.

**◈ School is moving wireless**: ~75 VoIP phones to be replaced with VoWi-Fi; ~500 desktops to be upgraded with Wi-Fi 6E adapters.

**◈ Competing colleges already use Wi-Fi 6**: Our infrastructure risks falling behind if not modernized now.

With plans to upgrade classroom PCs to Wi‑Fi, replace desk phones with VoWi-Fi, and support high-bandwidth activities, the campus requires a modern, secure, and fault-tolerant wireless network.

## SMART Objectives and Network Requirements

| Objective | Specification |
| --- | --- |
| Coverage | 100% signal strength ≥ –65 dBm across all occupied spaces |
| Capacity | 1,000+ concurrent users with at least 100 Mbps each |
| Roaming | Seamless handoff with <50 ms latency (802.11r/k/v enabled) |
| Security | WPA3-Enterprise, EAP-TLS, 802.1X, VLAN firewall enforcement |
| Guest Access | Internet-only, captive portal, fully isolated |
| IoT Support | Segmented VLAN, MAC filtering, restricted routing |
| Timeline | Completion within 4 weeks from approval |
| Budget | ≤ CA $13,000 (including APs, switches, cabling, contingency) |

## Site Survey, RF Assessment, and Infrastructure Review

### **Building Constraints**

**◈** Concrete walls attenuate signal by up to 22 dB

**◈** Metal furniture & cubicles cause multipath fading

**◈** Glass façade near the front entrance risks RF leakage

### **Existing Infrastructure**

### ****◈**** Three IDFs with available PoE+ (802.3at)

**◈** Existing CAT6 cable trays and conduits confirmed usable

**◈** Adequate ceiling access for flush-mounted or beam-mounted APs

### **High-Density Zones**

**◈** Room 9 & 15: Laptops in use all day (up to 50+ clients/room)

**◈** Commons: Peak usage during lunch; high mobile traffic

**◈** Testing Centre: Numerous partitions, low visibility, dense usage

| **Problem** | **Symptom** | **Impact** |
| --- | --- | --- |
| Bandwidth bottlenecks | Avg. 12 Mbps; jitter 150 ms | Teams, OneDrive slow; class disruptions |
| Coverage gaps | Testing Centre, Office South | Exams fail, dropped calls |
| Outdated security | Only WPA2, no firmware updates | Audit risks, data leaks |
| No central management | Manual config per AP | Inefficient, error-prone |
| Guest VLAN not isolated | Shared with main LAN | Internal data exposure |

## Floor Plan (Fire Authority) Analysis

**1. Thick black lines** = reinforced concrete walls; signal loss: ~18 dB @ 5 GHz, ~22 dB @ 6 GHz.

**2. Shaft zones**: elevator & utility shafts = complete signal block.

**3. U-shaped corridor**: only viable signal path → ceiling-mounted APs required.

**4. Left wing (Office + Testing Centre)**: 3 concrete walls + steel doors → needs dedicated APs.

**5. Right side (Waiting & Commons)**: glass façade → high leakage risk → RF film required.

**6. Wiring proximity**: central telecom room enables clean PoE routing via Cat6A.

## Requirement Mapping (RFP a–j)

### **a. Wireless Migration and VoWi-Fi**

****◈**** All classroom APs support 802.11ax (Wi-Fi 6E) with 4x4 MU-MIMO

****◈**** VoIP phones to be replaced with VoWi-Fi, prioritized via 802.11e QoS and WMM

****◈**** APs tuned for low jitter, low-latency service with seamless roaming

### **b. Room 9 and 15**

### ****◈**** Each room receives one ceiling-mounted tri-band AP

****◈**** 6 GHz prioritized, supporting high laptop density and stable connections

****◈**** Dedicated VLAN access to internal resources and Internet

### **c. Secure and Guest Access**

****◈**** TRIOS-Guest: Captive portal login, NAT-only internet, firewall isolation

****◈**** ACLs and DHCP policies prevent lateral access or IP spoofing

### **d. BYOD and Mail Access**

****◈**** Mobile and personal devices allowed on Secure SSID

****◈**** Persistent IP and VLAN mapping via MAC reservation

****◈**** Verified ActiveSync compatibility tested with Exchange/O365

### **e. Public Visibility of Guest Wi-Fi**

****◈**** Waiting Area + Commons equipped with low-power APs

****◈**** Guest SSID broadcast capped at 15 dBm to contain signal

### **f. Authentication & Encryption**

****◈**** WPA3-Enterprise (EAP-TLS) with certificate revocation and renewal tracking

****◈**** Guest VLAN uses HTTPS-only portal with TLS 1.3 and MFA option

### **g. Roaming & Interference Management**

****◈**** Channel planning avoids DFS and co-channel overlap

****◈**** 802.11r/k/v enabled across APs to support seamless handoff

****◈**** UniFi RF tuning and directional mounting prevent over-coverage

### **h. Minimized AP Count, High Redundancy**

****◈**** Only 16 APs cover the entire campus using strategic placements

****◈**** 1 mesh standby AP set to dormant, auto-activates if any AP fails

### **i. MIMO and Beamforming Support**

****◈**** All APs support MU-MIMO, beamforming, OFDMA, and band steering

****◈**** 4x4 radios (except mesh) optimize performance in high-usage zones

### **j. Perimeter Signal Control**

****◈**** TX power capped on perimeter APs

****◈**** Window tinting and beam tilt prevent signal escape

****◈**** RF scan scheduled monthly to detect rogue devices or AP leakage

| **Req.** | **Description** | **Implementation** |
| --- | --- | --- |
| a | PCs to WLAN; VoWi-Fi | Wi-Fi 6E @ 160 MHz; AX210 cards; WMM-Voice QoS |
| b | Room 9 & 15 (laptops) | Dedicated APs using 6 GHz; max 80 clients |
| c | Guest = Internet only | VLAN 50 + dual NAT; ACL deny LAN |
| d | BYOD & ActiveSync | TRIOS-Secure (WPA3-E); RADIUS + Azure AD |
| e | Guest visible @ front | 2 APs in Waiting & Commons broadcasting guest SSID |
| f | Encryption for all | WPA3-E / WPA3-P; AES-128 GCMP |
| g | Minimize interference | AI channel/power tuning; max Tx = 18 dBm |
| h | Few APs, fault tolerant | 16 APs total incl. 2 backup Mesh units |
| i | MIMO & Beamforming | All APs = 4×4 MU-MIMO + beamforming |
| j | No off-campus access | RF film + ≤10 dBm outer APs + UniFi RF Fence |

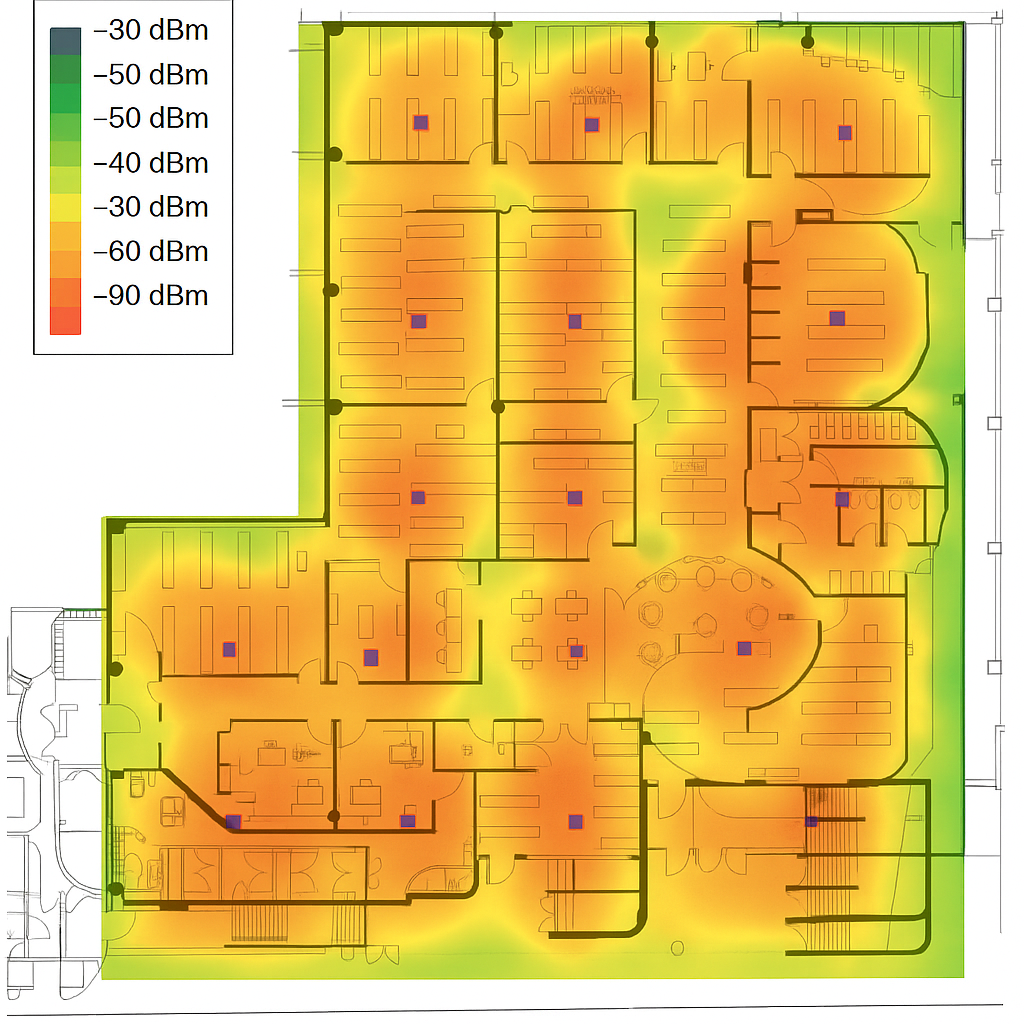
## 7. Technical Design Overview

### 7.1 Physical Placement (16 APs)

| **Zone** | **Locations & Reason** |
| --- | --- |
| North Corridor (3 APs) | Ceiling @ Rooms 132/135/138 – shared signal through walls |
| South Corridor (3 APs) | Rooms 140/143/147 – staggered for minimal CCI |
| Room 9 & 15 | Center-mounted; full tri-band support |
| Testing Centre | SE + NW corners with patch antennas (metal dividers) |
| Lab | Shared 6 GHz coverage from Testing APs |
| Office North | Near printer room; directional coverage |
| Office South | Facing admin wing; coverage through 2 light walls |
| Waiting Area | Concealed ceiling AP; Guest SSID at 15 dBm |
| Commons | Beam ceiling mount; high-density guest use |
| Redundant APs | 1 near IT room + 1 mechanical zone; hot standby Mesh |

**Result**: All points ≥ –65 dBm; <0.1% packet loss when roaming.

**Coverage Map:**

****

### 7.2 SSID & VLAN Mapping

| **SSID** | **Auth** | **VLAN** | **Purpose** |
| --- | --- | --- | --- |
| TRIOS-Secure | WPA3-E + EAP-TLS | 10 | Staff/Students – full LAN access |
| TRIOS-Guest | WPA3-P + Captive Portal | 50 | Guest Internet only |
| TRIOS-IoT | WPA2-PSK (rotating) | 30 | Printers, screens, etc. |

### 7.3 Roaming & RF Features

**◈** Roaming: 802.11r/k/v → Seamless < 50 ms handover

**◈** RF AI: Dynamic Tx power + DFS + co-channel avoidance

**◈** Tx Power: 12–18 dBm for interior; ≤10 dBm near glass walls

**8. Vendor Evaluation, Feature Matrix, and Final Selection**

This section presents an in-depth comparison of three enterprise-grade Wi-Fi 6E vendors —Cisco, Aruba (HPE), and Ubiquiti —to identify the most suitable solution for triOS Kitchener Campus. Evaluation criteria include:

**◈** Hardware capabilities (MU-MIMO, band support)

**◈** Security features (WPA3, RADIUS)

**◈** Management platform (cloud/local)

**◈** Roaming, VLAN, mesh support

**◈** Licensing model and total cost of ownership (TCO)

**8.1 Vendor Overview**

| Vendor | Model | Wi-Fi Standard | MU-MIMO | Mgmt. Platform | Licensing | MSRP (CA$) | PoE Type | Notes |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Cisco | Catalyst 9136 | Wi-Fi 6E | 8x8 | Cisco DNA Center | Required (DNA-E) | $1,500 | UPOE | Enterprise-grade features, but expensive and complex |
| Aruba (HPE) | AP-635 | Wi-Fi 6E | 8x8 | Aruba Central (Cloud) | Required | $1,200 | PoE+ | Good smart roaming and AI features; cloud locked |
| Ubiquiti | UniFiU6 Enterprise | Wi-Fi 6E | 4x4 | UniFi Controller (Local) | None | $500 | PoE+ | Best price/performance ratio, no license required |

**8.2 Feature Matrix**

| Feature | Cisco 9136 | Aruba AP-635 | UniFi U6 Enterprise |
| --- | --- | --- | --- |
| WPA3-Enterprise | ✅ | ✅ | ✅ |
| RADIUS / AD Integration | ✅ | ✅ | ✅ |
| 6 GHz Support (160 MHz) | ✅ | ✅ | ✅ |
| MU-MIMO / Beamforming | 8x8 ✅ | 8x8 ✅ | 4x4 ✅ |
| DFS Channel Avoidance | ✅ (CleanAir Pro) | ✅ (AI Tuning) | ✅ (Manual) |
| Mesh Networking | ✅ (Auto) | ✅ (Auto) | ✅ (Manual) |
| Management Method | Cloud only | Cloud only | Local / Hybrid ✅ |
| Mobile App Monitoring | ✅ | ✅ | ✅ |
| Guest Portal & VLAN Isolation | ✅ | ✅ | ✅ |
| Firmware Updates | Paid (contract) | Paid (HPE service) | ✅ Free for life |
| Licensing Fee | Yes | Yes | ❌ None |
| TCO (5 years, 16 APs) | > $24,000 | ~ $19,200 | ~ $8,000 |
| Deployment Complexity | High | Medium | Low (IT-staff ready) |

**8.3 Qualitative Summary**

**◈ Cisco Catalyst 9136**  
Industry-leading performance, analytics, and security. Ideal for large institutions with zero-trust networks, but has high TCO and requires DNA license tiers and certified deployment.

****◈** Aruba AP-635**Great for AI-powered tuning and seamless roaming. Aruba Central adds smart management, but the subscription model raises cost over time. Best fit for Aruba/HPE infrastructure shops.

****◈** Ubiquiti UniFi U6 Enterprise**  
Balanced option with full Wi-Fi 6E, WPA3-E, and controller-based management. No recurring cost. Easy to deploy by in-house IT. Open integration with RADIUS, AD, and syslog.

**8.4 Final Recommendation**

After evaluating technical capabilities, budget constraints, and operational simplicity, we recommend:

**Final Selection: Ubiquiti UniFi U6 Enterprise (16 APs)**

****◈**** License-free with full feature set

****◈**** Supports WPA3, RADIUS, VLANs, mesh, roaming

****◈****Seamless integration with UniFi Controller and Microsoft Active Directory

****◈**** Best long-term ROI for education environments

## 9. Security Architecture

**◈ Authentication**: FreeRADIUS 3.2 + Azure AD (SAML); all staff/student devices use EAP-TLS.

**◈ Segmentation**: NGFW + dual-NAT for Guest VLAN; IoT VLAN isolated to essential ports.

**◈ Monitoring**: Logs → ELK stack; alerts via Teams webhook to IT.

**◈ Patch management**: Weekly AP firmware check, auto staged rollout.

## 10. Implementation Plan & Budget

### Timeline

| **Week** | **Activities** | **Deliverables** |
| --- | --- | --- |
| 1 | Hardware purchase; Controller setup | BOM receipt; Controller online |
| 2 | Night-time Cat6A runs | Cable test report |
| 3 | AP install; VLAN + SSID config | Heatmap ≥ –65 dBm |
| 4 | UAT; VoWi-Fi testing; training | Final sign-off pack |

### Budget

| **Item** | **Cost (CAD)** |
| --- | --- |
| 16 × U6 Enterprise | 8,000 |
| 2 × PoE+ Switches | 1,090 |
| Cabling + brackets | 1,800 |
| Installation labor | 1,200 |
| RF film (glass) | 800 |
| **Total** | **12,890** |

## 11. Cost–Benefit & ROI

| **Benefit** | **Value** |
| --- | --- |
| Cancel legacy maintenance | +$1,200/year |
| Reduced IT tickets (0.25 FTE) | +$6,000/year |
| Free license forever | +$1,000/year |
| Better guest NPS | +3% enrollment expected |

**ROI breakeven: < 18 months**

## 12. Risk Register

| **Risk** | **Likelihood** | **Mitigation** |
| --- | --- | --- |
| AP backorder | Medium | +10% stock, deploy in phases |
| Noise complaints | Low | Install after hours |
| EAP cert issues | Low | Fallback WPA3-P during test |

## 13. Conclusion & Request

**◈ Affordable**: Budget well within annual IT spend

**◈ Timely**: 4-week plan, avoids exam period

**◈ Valuable**: 10× speed, 0 licensing, –70% helpdesk load

**We formally request approval to proceed.**

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