



NGORONGORO CONSERVATION AREA AUTHORITY

Software Requirements Specification

NCAA Digital Transformation - Infrastructure & Hardware Module

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<https://www.ncaa.go.tz>

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1 Document Information

Field	Value
Project Name	NCAA Digital Transformation - Infrastructure & Hardware Module
Version	1.0
Date	2025-11-06
Project Manager	TBD
Tech Lead	TBD
Qa Lead	TBD
Platforms	['Hardware', 'Network', 'Infrastructure']
Document Status	Draft
Module Code	INFRASTRUCTURE
Parent Project	NCAA Digital Transformation - Ngorongoro Gateway System

2 Project Overview

2.1 What Are We Building

2.1.1 System Function

Complete hardware and network infrastructure for 9 gates, each equipped with Intel NUC application server, NAS backup system, WiFi access point, staff workstations (desktop PC and tablet), network infrastructure, and UPS power backup. System designed for reliable offline-first operation in remote locations with challenging conditions.

2.1.2 Users

- Gate Staff: Use desktop PC and tablets for daily operations
- IT Staff: Maintain and troubleshoot hardware
- System Administrators: Monitor infrastructure health
- Management: Review infrastructure costs and performance

2.1.3 Problem Solved

Aging infrastructure from 1959 at Lemala, no computer at Lemala 2, unreliable power at Ndutu (no electricity), no WiFi for mobile operations, no backup systems causing data loss risk, no standardized hardware across gates causing maintenance challenges, insufficient infrastructure at Main Gate causing staff overwork

2.1.4 Key Success Metric

All 9 gates equipped with standardized hardware, 99.5% hardware uptime, 2-4 hour UPS runtime, WiFi coverage for mobile operations, complete backup redundancy (NUC → NAS → USB), total project cost ~\$22,600 for 9 gates (~\$2,215 per gate)

2.2 Scope

2.2.1 In Scope

- Intel NUC application servers (9 units + 2 spares)
- NAS backup systems with RAID 1 (9 units)

- WiFi access points (9 units)
- Desktop PC workstations (9 units)
- Tablets for mobile operations (9 units)
- Network switches (9 units)
- UPS power backup (9 units, 1000VA each)
- Barcode/QR scanners (9 units)
- Receipt printers (9 units)
- IP cameras for vehicle inspection (9+ units)
- Network cabling and accessories
- Spare parts buffer (10%)
- Installation and setup
- Staff training on hardware
- Maintenance procedures and documentation

2.2.2 Out Of Scope

- Internet connectivity (existing infrastructure)
- Building modifications or construction
- Solar power systems (except where existing needs repair)
- Satellite communication systems
- Building HVAC or climate control
- Physical security systems (locks, barriers)
- Furniture or office equipment beyond computers

3 User Requirements

3.1 Compute Storage

Feature Code	I Want To	So That I Can	Priority	Notes
FT-INFRA-NUC-SETUP	Deploy Intel NUC as primary application server at each gate	Run PostgreSQL, Python backend, and React PWA locally with fast performance	Must	Intel NUC 11/12, 16GB RAM, 512GB NVMe SSD. Ubuntu Server 22.04 LTS. Cost ~\$300 per unit.
FT-INFRA-NUC-SPECS	Ensure NUC has sufficient processing power for real-time operations	Handle vehicle detection, database queries, and sync without performance issues	Must	Minimum Intel i5, prefer i7. Support for 24/7 operation. Passive cooling preferred for dusty environment.
FT-INFRA-NUC-REDUNDANCY	Maintain 2 spare NUC units at Old HQ	Quickly replace failed units at remote gates	Must	Spare units pre-configured and ready to deploy. Documented replacement procedure. Cost: 2 units @ \$300 = \$600.
FT-INFRA-NAS-SETUP	Deploy NAS with RAID 1 at each gate for backup storage	Protect against data loss with hourly backups and disk redundancy	Must	4-bay Synology/ QNAP, 2x 2TB HDD RAID 1. Supports snapshots. Cost: ~\$700 NAS + \$150 drives = \$850 per gate.

Feature Code	I Want To	So That I Can	Priority	Notes
FT-INFRA-NAS-CAPACITY	Ensure NAS has sufficient capacity for 30+ days backup retention	Maintain complete backup history for recovery and audit	Must	2TB per drive sufficient for estimated 50GB/month growth. RAID 1 provides 2TB usable.

3.2 Network Infrastructure

Feature Code	I Want To	So That I Can	Priority	Notes
FT-INFRA-WIFI-AP	Deploy WiFi access points at all gates	Enable tablet usage for mobile registration and inspection	Must	Outdoor AP (TP-Link EAP or Ubiquiti). Weather-resistant. Coverage 50-100m. Cost ~\$150-200 per unit.
FT-INFRA-SWITCH	Deploy network switch at each gate	Connect NUC, NAS, AP, desktop PC, and cameras	Must	5-8 port gigabit switch. PoE support preferred for cameras and AP. Cost ~\$30-50 per unit.
FT-INFRA-CABLING	Properly cable network infrastructure	Ensure reliable connectivity between devices	Must	Cat6 ethernet cables. Cable management. Outdoor-rated where needed. Cost ~\$20 per gate.
FT-INFRA-TOPOLOGY	Implement standardized network	Simplify troubleshooting and maintenance	Must	Standard topology: NUC → Switch → (NAS, AP, PC, Camera).

Feature Code	I Want To	So That I Can	Priority	Notes
	topology across all gates			Internet via existing connection to Switch.

3.3 Staff Devices

Feature Code	I Want To	So That I Can	Priority	Notes
FT-INFRA-PC-WORKSTATION	Deploy desktop PC as primary workstation at each gate	Provide staff with reliable computing for registration and operations	Must	Budget desktop PC (~\$300-400). Connects via ethernet/WiFi to NUC. Monitor, keyboard, mouse included.
FT-INFRA-TABLET	Deploy tablet for mobile operations at each gate	Enable mobile vehicle inspection and visitor registration	Must	Android/iPad tablet (~\$200). WiFi only. Ruggedized case. PWA access to system.
FT-INFRA-PERIPHERALS	Provide barcode scanners and receipt printers	Support permit scanning and receipt printing	Must	Barcode/QR scanner ~\$50-100. Receipt printer ~\$100-150. USB connection to PC.

3.4 Power Backup

Feature Code	I Want To	So That I Can	Priority	Notes
FT-INFRA-UPS-DEPLOYMENT	Deploy UPS at each gate for power backup	Maintain operations during power outages	Must	UPS 1000VA (~\$150-200). Powers NUC + NAS + Switch.

Feature Code	I Want To	So That I Can	Priority	Notes
		common at remote locations		Runtime 2-4 hours. USB/network management.
FT-INFRA-UPS-CAPACITY	Ensure UPS capacity sufficient for 2-4 hour runtime	Cover typical power outage duration	Must	Load: NUC (65W) + NAS (50W) + Switch (10W) = ~125W. 1000VA UPS provides 3-4hr at this load.

3.5 Camera Systems

Feature Code	I Want To	So That I Can	Priority	Notes
FT-INFRA-CAM-IP	Deploy IP cameras for vehicle inspection	Enable automated vehicle detection and documentation	Must	IP camera 1080p+, H.264/H.265. PoE powered. Adjustable mount. Weather-resistant. Cost ~\$200-300 per camera.
FT-INFRA-CAM-MOUNT	Install adjustable camera mounts	Capture vehicles of varied heights (1.5m to 4m)	Must	Adjustable mounting hardware. Manual or motorized adjustment. Per

Feature Code	I Want To	So That I Can	Priority	Notes
				Nov 3 revision feedback.
FT-INFRA-CAM-MULTI	Deploy multiple cameras at high-volume gates	Capture multiple angles (front, side) at busy locations like Seneto	Should	2-3 cameras at Karatu, Seneto, Main Gate. Single camera at remote gates. Budget for 15 total cameras.

3.6 Installation

Feature Code	I Want To	So That I Can	Priority	Notes
FT-INFRA-INSTALL-PILOT	Install and configure hardware at 3 pilot gates first	Validate setup and identify issues before full deployment	Must	Pilot gates: Karatu, Seneto, Main Gate. Test all components. Refine installation procedures.
FT-INFRA-INSTALL-REMOTE	Plan installation at remote locations with logistics challenges	Successfully deploy hardware at Ndutu, Lemala 1&2 despite access difficulties	Must	Remote locations require 4WD access. Coordinate with NCAA staff. Plan for multi-day installation.
FT-INFRA-INSTALL-CONFIG	Pre-configure NUC and NAS units before deployment	Minimize on-site configuration time at remote gates	Must	Configure at Old HQ: OS, PostgreSQL, PWA, network settings. Test before transport.
FT-INFRA-INSTALL-DOCS	Document installation procedures with photos	Enable future maintenance and troubleshooting	Must	Installation manual with photos. Network diagram per

Feature Code	I Want To	So That I Can	Priority	Notes
				gate. Configuration checklist.

3.7 Maintenance

Feature Code	I Want To	So That I Can	Priority	Notes
FT-INFRA-MAINT-SCHE	Establish maintenance schedule for all hardware	Prevent failures and extend hardware lifespan	Must	Monthly: clean dust filters, check connections. Quarterly: UPS battery test. Annually: hardware inspection.
FT-INFRA-MAINT-REMOTE	Enable remote troubleshooting capabilities	Resolve issues without traveling to remote gates	Must	SSH access from Old HQ. Remote desktop. System monitoring. Reduces need for site visits.
FT-INFRA-MAINT-SPARES	Maintain 10% spare parts buffer	Quickly replace failed components	Must	Spares at Old HQ: 2x NUC, hard drives, power supplies, cables, switches. Cost ~\$2,000.
FT-INFRA-MAINT-TRAINING	Train local staff on basic hardware maintenance	Enable first-level troubleshooting at gates	Must	Training: restart procedures, basic network troubleshooting, when to escalate. Laminated quick reference guides.

3.8 Environmental

Feature Code	I Want To	So That I Can	Priority	Notes
FT-INFRA-ENV-DUST	Protect hardware from dust in conservation area	Prevent premature hardware failure	Must	Enclosed racks or cabinets. Dust filters. Regular cleaning schedule. Passive cooling preferred.
FT-INFRA-ENV-HEAT	Ensure hardware operates in high temperatures	Maintain reliability in hot climate	Must	Hardware rated for 0-40°C operation. Adequate ventilation. Monitor temps. Passive cooling for NUC.
FT-INFRA-ENV-WEATHER	Protect outdoor equipment from weather	Maintain WiFi and camera reliability	Must	Weather-resistant enclosures. IP65+ rating for outdoor devices. Lightning protection for antennas.

3.9 Cost Management

Feature Code	I Want To	So That I Can	Priority	Notes
FT-INFRA-COST-BUDGET	Deliver project within ~\$22,600 budget for 9 gates	Meet financial constraints while achieving goals	Must	Budget: \$20,000 hardware (9 gates @ \$2,215) + \$600 spare NUCs + \$2,000 spare parts = \$22,600.
			Must	

Feature Code	I Want To	So That I Can	Priority	Notes
FT-INFRA-COST-TRACKING	Track costs per gate during procurement	Ensure budget compliance and identify cost savings		Detailed cost tracking spreadsheet. Bulk purchase discounts. Local vs international procurement comparison.
FT-INFRA-COST-TCO	Calculate total cost of ownership including maintenance	Plan for ongoing operational costs	Should	TCO: hardware (\$22,600), maintenance (est \$2,000/year), power (UPS batteries \$150/year per gate), replacement cycle (5 years).

4 Technical Requirements

4.1 Performance Standards

Requirement	Target	How To Test
Hardware uptime	≥ 99.5%	Monitor uptime over 90 days, including UPS failover events
UPS runtime	2-4 hours at typical load	Full load test with mains disconnected
WiFi coverage	50-100m radius per gate	Site survey with tablets at various distances
Network throughput	≥ 100 Mbps local network	iperf between devices
NUC query response	< 100ms for 95% of queries	Database performance testing

4.2 Platform Requirements

Platform	Minimum Version	Target Version	Notes
Intel NUC	NUC 11 with i5, 16GB RAM, 512GB NVMe	NUC 12 with i7, 16GB RAM, 512GB NVMe	Ubuntu Server 22.04 LTS pre-installed
NAS	4-bay Synology DS420j or QNAP TS-453D	Synology DS423+ or QNAP TS-464	2x 2TB HDD (WD Red or Seagate IronWolf) in RAID 1
WiFi AP	TP-Link EAP225-Outdoor or Ubiquiti UAP-AC-M	TP-Link EAP245 or Ubiquiti UAP-AC-PRO	Weather-resistant, 802.11ac minimum, PoE powered
UPS	APC Back-UPS 1000VA or CyberPower CP1000	APC Smart-UPS 1000VA with network card	USB/network management, 2-4hr runtime at 125W load

4.3 Security Privacy

Requirement	Must Have	Implementation
Physical security for equipment	True	Locked racks/cabinets at each gate. Access limited to authorized staff.
Network security	True	Firewalls on NUCs. WiFi WPA3 encryption. Network segmentation.
Hardware asset tracking	True	Asset register with serial numbers, locations, purchase dates. Annual inventory.



5 External Dependencies

5.1 Third Party Services

Service	What It Does	Criticality	Backup Plan
Internet Service Provider	Existing internet connectivity	Nice to have	Offline operation, cellular data for sync

5.2 Device Requirements

Feature	Required	Optional	Notes
4WD vehicle access to remote gates	True	False	Required for installation at Ndutu, Lemala 1&2
Existing electrical infrastructure	True	False	Grid power or solar. Ndutu has no electricity (requires solar upgrade).

6 Release Planning

6.1 Development Phases

Phase	Features Included	Timeline	Success Criteria
Phase 1 (Pilot - 3 Gates)	[‘Hardware procurement’, ‘Installation at Karatu, Seneto, Main Gate’, ‘Configuration and testing’, ‘Staff training’]	8 weeks	3 gates fully operational, hardware performing to spec, staff trained and confident
Phase 2 (Intermediate - 3 Gates)	[‘Installation at Old HQ, Nabi, Olduvai’, ‘Lessons learned from pilot applied’, ‘Remote support procedures established’]	6 weeks	6 gates operational, standardized installation procedures, remote troubleshooting working
Phase 3 (Remote - 3 Gates)	[‘Installation at Ndutu, Lemala 1, Lemala 2’, ‘Solar system assessment/upgrade where needed’, ‘Complete documentation’]	8 weeks	All 9 gates operational, solar power stable, complete maintenance documentation

6.2 Release Checklist

- All hardware procured and inventory verified
- NUC and NAS units pre-configured at Old HQ
- Network topology documented per gate
- Installation completed at all 9 gates
- UPS runtime tested and verified (2-4 hours)
- WiFi coverage verified at all gates

- Camera systems operational where deployed
- Spare parts buffer established at Old HQ (2x NUC, drives, etc)
- Maintenance schedule established
- Staff trained on hardware operation and basic troubleshooting
- Remote access configured for all gates
- Hardware warranty and support contracts in place
- Asset register complete with all serial numbers



7 Risks Assumptions

7.1 Risks

Risk	Probability	Impact	Mitigation
Hardware delays due to import/shipping challenges in Tanzania	Medium	Medium	Early procurement, local suppliers for some items, buffer in timeline
Harsh environment causing premature hardware failure	Medium	High	Ruggedized equipment, dust protection, spare parts buffer, extended warranties
Power infrastructure inadequate at remote locations	High	High	UPS backup, solar system upgrades where needed, low-power hardware choices
Remote gate access difficulties delaying installation	Medium	Medium	Coordinate with NCAA logistics, 4WD vehicle arranged, multi-day installation windows
Hardware theft or vandalism at remote locations	Low	High	Locked cabinets, physical security, insurance, asset tracking, local security awareness

7.2 Assumptions

- Bulk purchase discounts achievable for ~30% savings
- Local power infrastructure adequate with UPS backup

- Remote gates accessible by vehicle during installation
- Staff capable of basic hardware operation with training
- Existing network infrastructure can be leveraged where available
- Hardware lifespan 5+ years with proper maintenance
- Spare parts available locally or via 2-week shipping



8 Market Specific Considerations

8.1 Primary Market

- Ngorongoro Conservation Area, Tanzania - 9 remote gates

8.2 Target Demographics

- Gate staff using hardware daily
- IT staff maintaining systems

8.3 Local Considerations

- Dusty environment requiring frequent cleaning
- High temperatures (up to 40°C) requiring adequate cooling
- Remote locations with limited vehicle access
- Limited local technical expertise requiring simple, reliable hardware
- Import duties and shipping costs for hardware
- Tanzania power standards (230V, 50Hz, Type D/G plugs)
- Aging infrastructure at some gates (Lemala 1 from 1959)

8.4 Hardware Availability

8.4.1 Local Dar Es Salaam

Desktop PCs, tablets, cables, some networking gear

8.4.2 Regional Nairobi

Intel NUCs, WiFi APs, switches, UPS

8.4.3 International

NAS units, specialized cameras, high-end equipment

9 Sign Off

9.1 Approval

Role	Name	Signature	Date

9.2 Document History

Version	Date	Changes Made	Changed By
1.0	2025-11-06	Initial draft based on gate nodes architecture document	Development Team

10 Detailed Feature Requirements

10.1 Ft Infra Nuc Setup

10.1.1 Priority

Must Have

10.1.2 User Story

As an IT administrator, I want to deploy Intel NUC as primary application server at each gate so that I can run PostgreSQL, Python backend, and React PWA locally with fast performance

10.1.3 Preconditions

Intel NUC 11/12 procured; Ubuntu Server 22.04 LTS image prepared; network configured

10.1.4 Postconditions

NUC operational at gate; PostgreSQL running; PWA accessible; verified performance benchmarks met

10.1.5 Test Cases

Id	Description	Weight
INFRA-NUC-TC-001	Install Ubuntu Server 22.04 LTS on NUC	High
INFRA-NUC-TC-002	Install and configure PostgreSQL 15+ on NUC	High
INFRA-NUC-TC-003	Deploy Python backend and React PWA	High
INFRA-NUC-TC-004	Verify query response time <100ms	High
INFRA-NUC-TC-005	Test 24/7 continuous operation for 7 days	High

10.2 Ft Infra Nuc Specs

10.2.1 Priority

Must Have

10.2.2 User Story

As an IT administrator, I want NUC to have sufficient processing power for real-time operations so that vehicle detection, database queries, and sync run without performance issues

10.2.3 Preconditions

NUC specifications validated; processing requirements documented

10.2.4 Postconditions

NUC meets all performance benchmarks; vehicle detection runs in <5 seconds; database queries <100ms

10.2.5 Test Cases

Id	Description	Weight
INFRA-NUC-TC-006	Verify Intel i5/i7 processor installed	High
INFRA-NUC-TC-007	Verify 16GB RAM installed and available	High
INFRA-NUC-TC-008	Verify 512GB NVMe SSD performance (read/write speeds)	High
INFRA-NUC-TC-009	Test real-time vehicle detection performance	High
INFRA-NUC-TC-010	Load test with concurrent database operations	High

10.3 Ft Infra Nuc Redundancy

10.3.1 Priority

Must Have

10.3.2 User Story

As an IT manager, I want to maintain 2 spare NUC units at Old HQ so that I can quickly replace failed units at remote gates

10.3.3 Preconditions

2 additional NUC units procured; pre-configuration completed; documentation prepared

10.3.4 Postconditions

Spare NUCs ready for deployment; replacement procedure tested; staff trained

10.3.5 Test Cases

Id	Description	Weight
INFRA-NUC-TC-011	Pre-configure 2 spare NUC units with standard image	High
INFRA-NUC-TC-012	Document and test replacement procedure	High
INFRA-NUC-TC-013	Verify spare NUC can replace operational unit in <2 hours	High

10.4 Ft Infra Nas Setup

10.4.1 Priority

Must Have

10.4.2 User Story

As an IT administrator, I want to deploy NAS with RAID 1 at each gate so that I can protect against data loss with hourly backups and disk redundancy

10.4.3 Preconditions

NAS unit and 2x 2TB drives procured; network configured; backup scripts prepared

10.4.4 Postconditions

NAS operational with RAID 1; hourly backups configured; verification successful

10.4.5 Test Cases

Id	Description	Weight
INFRA-NAS-TC-001	Configure NAS with 2x 2TB drives in RAID 1	High
INFRA-NAS-TC-002	Configure hourly backup from NUC to NAS	High
INFRA-NAS-TC-003	Verify backup completes in <10 minutes	High
INFRA-NAS-TC-004	Test single drive failure recovery	High
INFRA-NAS-TC-005	Configure daily snapshots with 30-day retention	High

10.5 Ft Infra Nas Capacity

10.5.1 Priority

Must Have

10.5.2 User Story

As an IT administrator, I want NAS to have sufficient capacity for 30+ days backup retention so that I can maintain complete backup history for recovery and audit

10.5.3 Preconditions

Storage requirements calculated; 2TB RAID 1 configuration validated

10.5.4 Postconditions

NAS has adequate capacity; storage monitoring configured; alerts set at 80%

10.5.5 Test Cases

Id	Description	Weight
INFRA-NAS-TC-006	Verify 2TB usable capacity available	High
INFRA-NAS-TC-007	Monitor storage growth over 30 days	Medium
INFRA-NAS-TC-008	Test storage alert at 80% capacity	Medium
INFRA-NAS-TC-009	Verify 30-day backup retention maintained	High

10.6 Ft Infra Wifi Ap

10.6.1 Priority

Must Have

10.6.2 User Story

As a gate staff member, I want WiFi access points at all gates so that I can use tablets for mobile registration and inspection

10.6.3 Preconditions

Outdoor WiFi AP procured; mounting location identified; network configured

10.6.4 Postconditions

WiFi operational with 50-100m coverage; tablets connected; performance verified

10.6.5 Test Cases

Id	Description	Weight
INFRA-WIFI-TC-001	Install and configure outdoor WiFi AP	High
INFRA-WIFI-TC-002	Verify WiFi coverage 50-100m radius	High
INFRA-WIFI-TC-003	Test tablet connectivity and performance	High
INFRA-WIFI-TC-004	Verify weather-resistant housing protection	Medium
INFRA-WIFI-TC-005	Test WPA3 encryption and security	High

10.7 Ft Infra Switch

10.7.1 Priority

Must Have

10.7.2 User Story

As an IT administrator, I want a network switch at each gate so that I can connect NUC, NAS, AP, desktop PC, and cameras

10.7.3 Preconditions

5-8 port gigabit switch procured; PoE capability verified; cabling prepared

10.7.4 Postconditions

Switch operational; all devices connected; gigabit throughput verified

10.7.5 Test Cases

Id	Description	Weight
INFRA-NET-TC-001	Install and configure network switch	High
INFRA-NET-TC-002	Connect all devices (NUC, NAS, AP, PC, cameras)	High
INFRA-NET-TC-003	Verify gigabit throughput (≥ 100 Mbps)	High
INFRA-NET-TC-004	Test PoE power delivery to cameras and AP	High

10.8 Ft Infra Cabling

10.8.1 Priority

Must Have

10.8.2 User Story

As an IT administrator, I want properly cabled network infrastructure so that I can ensure reliable connectivity between devices

10.8.3 Preconditions

Cat6 ethernet cables procured; cable management hardware ready; outdoor-rated cables where needed

10.8.4 Postconditions

All devices properly cabled; cable management neat; outdoor cabling weatherproof

10.8.5 Test Cases

Id	Description	Weight
INFRA-NET-TC-005	Cable all devices with Cat6 ethernet	High
INFRA-NET-TC-006	Install cable management for organization	Medium

Id	Description	Weight
INFRA-NET-TC-007	Test cable integrity and throughput	High
INFRA-NET-TC-008	Verify outdoor cables weatherproof	Medium

10.9 Ft Infra Topology

10.9.1 Priority

Must Have

10.9.2 User Story

As an IT administrator, I want standardized network topology across all gates so that I can simplify troubleshooting and maintenance

10.9.3 Preconditions

Standard topology documented; network diagram prepared; IP addressing scheme defined

10.9.4 Postconditions

All gates follow standard topology; documentation complete; troubleshooting simplified

10.9.5 Test Cases

Id	Description	Weight
INFRA-NET-TC-009	Implement standard topology at each gate	High
INFRA-NET-TC-010	Document network topology with diagrams	High
INFRA-NET-TC-011	Verify consistent IP addressing across gates	High

10.10 Ft Infra Pc Workstation

10.10.1 Priority

Must Have

10.10.2 User Story

As a gate staff member, I want a desktop PC as primary workstation so that I can perform registration and operations reliably

10.10.3 Preconditions

Desktop PC procured; monitor, keyboard, mouse included; network connection ready

10.10.4 Postconditions

PC operational; PWA accessible; performance adequate for daily operations

10.10.5 Test Cases

Id	Description	Weight
INFRA-PC-TC-001	Install and configure desktop PC	High
INFRA-PC-TC-002	Connect PC to network (ethernet or WiFi)	High
INFRA-PC-TC-003	Access PWA and verify functionality	High
INFRA-PC-TC-004	Test daily operations performance	High

10.11 Ft Infra Tablet

10.11.1 Priority

Must Have

10.11.2 User Story

As a gate staff member, I want a tablet for mobile operations so that I can perform mobile vehicle inspection and visitor registration

10.11.3 Preconditions

Android/iPad tablet procured; ruggedized case included; WiFi configured

10.11.4 Postconditions

Tablet operational; PWA accessible; mobile operations tested successfully

10.11.5 Test Cases

Id	Description	Weight
INFRA-TABLET-TC-001	Configure tablet with PWA	High
INFRA-TABLET-TC-002	Test WiFi connectivity to gate network	High
INFRA-TABLET-TC-003	Verify mobile registration and inspection workflows	High
INFRA-TABLET-TC-004	Test ruggedized case protection	Medium

10.12 Ft Infra Peripherals

10.12.1 Priority

Must Have

10.12.2 User Story

As a gate staff member, I want barcode scanners and receipt printers so that I can scan permits and print receipts

10.12.3 Preconditions

Barcode/QR scanner and receipt printer procured; USB connections available

10.12.4 Postconditions

Peripherals operational; permit scanning working; receipt printing functional

10.12.5 Test Cases

Id	Description	Weight
INFRA-PERIPH-TC-001	Install and configure barcode/QR scanner	High
INFRA-PERIPH-TC-002	Install and configure receipt printer	High
INFRA-PERIPH-TC-003	Test permit scanning workflow	High
INFRA-PERIPH-TC-004	Test receipt printing workflow	High

10.13 Ft Infra Ups Deployment

10.13.1 Priority

Must Have

10.13.2 User Story

As a gate staff member, I want UPS at each gate for power backup so that operations continue during power outages

10.13.3 Preconditions

UPS 1000VA procured; load calculated (NUC+NAS+Switch ~125W); installation location identified

10.13.4 Postconditions

UPS operational; 2-4 hour runtime verified; monitoring configured

10.13.5 Test Cases

Id	Description	Weight
INFRA-UPS-TC-001	Install and configure UPS 1000VA	High
INFRA-UPS-TC-002	Connect NUC, NAS, and Switch to UPS	High
INFRA-UPS-TC-003		High

Id	Description	Weight
	Test runtime under full load (verify 2-4 hours)	
INFRA-UPS-TC-004	Configure USB/network management interface	High
INFRA-UPS-TC-005	Test automatic system notifications on power events	Medium

10.14 Ft Infra Ups Capacity

10.14.1 Priority

Must Have

10.14.2 User Story

As an IT administrator, I want UPS capacity sufficient for 2-4 hour runtime so that typical power outage duration is covered

10.14.3 Preconditions

Load calculation complete (NUC 65W + NAS 50W + Switch 10W = 125W); UPS specifications verified

10.14.4 Postconditions

Runtime requirement met; battery health monitoring configured; replacement schedule established

10.14.5 Test Cases

Id	Description	Weight
INFRA-UPS-TC-006	Verify load calculation accurate (measure actual draw)	High
INFRA-UPS-TC-007	Full discharge test to verify 2-4 hour runtime	High
INFRA-UPS-TC-008		Medium

Id	Description	Weight
	Configure battery health monitoring	
INFRA-UPS-TC-009	Test low battery alerts and graceful shutdown	High

10.15 Ft Infra Solar Upgrade

10.15.1 Priority

Should Have

10.15.2 User Story

As an IT manager, I want to repair/upgrade solar systems where needed so that reliable power is available at locations without grid power

10.15.3 Preconditions

Solar system assessment completed; Lemala 1 needs identified; budget allocated

10.15.4 Postconditions

Solar systems operational at off-grid locations; power reliability improved

10.15.5 Test Cases

Id	Description	Weight
INFRA-SOLAR-TC-001	Assess solar system condition at Lemala 1	Medium
INFRA-SOLAR-TC-002	Repair or upgrade solar system as needed	Medium
INFRA-SOLAR-TC-003	Verify solar power sufficient for gate operations	Medium

10.16 Ft Infra Cam Ip

10.16.1 Priority

Must Have

10.16.2 User Story

As a gate staff member, I want IP cameras for vehicle inspection so that automated vehicle detection and documentation is enabled

10.16.3 Preconditions

IP camera 1080p+ procured; PoE switch available; mounting location identified

10.16.4 Postconditions

Camera operational; vehicle detection working; images captured and archived

10.16.5 Test Cases

Id	Description	Weight
INFRA-CAM-TC-001	Install IP camera with PoE power	High
INFRA-CAM-TC-002	Configure camera for 1080p H.264/H.265	High
INFRA-CAM-TC-003	Test vehicle detection and image capture	High
INFRA-CAM-TC-004	Verify weather-resistant housing	Medium

10.17 Ft Infra Cam Mount

10.17.1 Priority

Must Have

10.17.2 User Story

As an IT administrator, I want adjustable camera mounts so that vehicles of varied heights (1.5m to 4m) can be captured

10.17.3 Preconditions

Adjustable mounting hardware procured; height range requirements documented

10.17.4 Postconditions

Camera mount adjustable; all vehicle heights capturable; stability verified

10.17.5 Test Cases

Id	Description	Weight
INFRA-CAM-TC-005	Install adjustable camera mount	High
INFRA-CAM-TC-006	Test capture of small cars (1.5m height)	High
INFRA-CAM-TC-007	Test capture of large buses (4m height)	High
INFRA-CAM-TC-008	Verify mount stability in wind	Medium

10.18 Ft Infra Cam Multi

10.18.1 Priority

Should Have

10.18.2 User Story

As an IT administrator, I want multiple cameras at high-volume gates so that multiple angles (front, side) are captured at busy locations

10.18.3 Preconditions

2-3 cameras allocated for high-volume gates (Karatu, Seneto, Main Gate); PoE capacity verified

10.18.4 Postconditions

Multiple cameras operational; synchronized capture; comprehensive vehicle documentation

10.18.5 Test Cases

Id	Description	Weight
INFRA-CAM-TC-009	Install 2-3 cameras at high-volume gates	Medium
INFRA-CAM-TC-010	Synchronize camera capture timing	Medium
INFRA-CAM-TC-011	Verify front and side angles captured	Medium

10.19 Ft Infra Install Pilot

10.19.1 Priority

Must Have

10.19.2 User Story

As a project manager, I want to install and configure hardware at 3 pilot gates first so that I can validate setup and identify issues before full deployment

10.19.3 Preconditions

Hardware for 3 gates procured; pilot gates selected (Karatu, Seneto, Main Gate); installation team ready

10.19.4 Postconditions

3 pilot gates operational; issues documented; installation procedures refined

10.19.5 Test Cases

Id	Description	Weight
INFRA-INSTALL-TC-001	Complete installation at Karatu gate	High
INFRA-INSTALL-TC-002	Complete installation at Seneto gate	High
INFRA-INSTALL-TC-003	Complete installation at Main Gate	High

Id	Description	Weight
INFRA-INSTALL-TC-004	Document lessons learned from pilot	High
INFRA-INSTALL-TC-005	Refine installation procedures based on pilot	High

10.20 Ft Infra Install Remote

10.20.1 Priority

Must Have

10.20.2 User Story

As a project manager, I want to plan installation at remote locations with logistics challenges so that hardware is successfully deployed at Ndutu, Lemala 1&2

10.20.3 Preconditions

4WD vehicle arranged; remote gate access coordinated; multi-day installation planned

10.20.4 Postconditions

Remote gates equipped despite access difficulties; hardware operational; logistics challenges overcome

10.20.5 Test Cases

Id	Description	Weight
INFRA-INSTALL-TC-006	Plan and execute Ndutu installation with 4WD access	High
INFRA-INSTALL-TC-007	Plan and execute Lemala 1 installation	High
INFRA-INSTALL-TC-008	Plan and execute Lemala 2 installation	High
INFRA-INSTALL-TC-009	Coordinate multi-day installation with NCAA staff	Medium

10.21 Ft Infra Install Config

10.21.1 Priority

Must Have

10.21.2 User Story

As an IT administrator, I want to pre-configure NUC and NAS units before deployment so that on-site configuration time at remote gates is minimized

10.21.3 Preconditions

Standard configuration documented; test environment at Old HQ available; all units received

10.21.4 Postconditions

All NUC and NAS units pre-configured; tested; ready for transport to gates

10.21.5 Test Cases

Id	Description	Weight
INFRA-CONFIG-TC-001	Configure OS and network settings on all NUCs	High
INFRA-CONFIG-TC-002	Install PostgreSQL and PWA on all NUCs	High
INFRA-CONFIG-TC-003	Configure NAS units with RAID 1 and backup scripts	High
INFRA-CONFIG-TC-004	Test each unit before transport	High

10.22 Ft Infra Install Docs

10.22.1 Priority

Must Have

10.22.2 User Story

As an IT administrator, I want installation procedures documented with photos so that future maintenance and troubleshooting is enabled

10.22.3 Preconditions

Documentation template prepared; camera available for photos; standard procedures defined

10.22.4 Postconditions

Complete installation manual with photos; network diagrams per gate; configuration checklists

10.22.5 Test Cases

Id	Description	Weight
INFRA-DOC-TC-001	Create installation manual with step-by-step photos	High
INFRA-DOC-TC-002	Document network topology for each gate	High
INFRA-DOC-TC-003	Create configuration checklist for each gate	High
INFRA-DOC-TC-004	Review and validate documentation completeness	Medium

10.23 Ft Infra Maint Schedule

10.23.1 Priority

Must Have

10.23.2 User Story

As an IT manager, I want to establish maintenance schedule for all hardware so that failures are prevented and hardware lifespan is extended

10.23.3 Preconditions

Maintenance requirements documented; schedule template prepared; responsibilities assigned

10.23.4 Postconditions

Maintenance schedule established; staff trained; first maintenance cycle completed

10.23.5 Test Cases

Id	Description	Weight
INFRA-MAINT-TC-001	Document monthly maintenance tasks (dust cleaning, connections)	High
INFRA-MAINT-TC-002	Document quarterly maintenance tasks (UPS battery test)	High
INFRA-MAINT-TC-003	Document annual maintenance tasks (hardware inspection)	Medium
INFRA-MAINT-TC-004	Train staff on maintenance procedures	High
INFRA-MAINT-TC-005	Complete first maintenance cycle at all gates	High

10.24 Ft Infra Maint Remote

10.24.1 Priority

Must Have

10.24.2 User Story

As an IT administrator, I want remote troubleshooting capabilities so that issues can be resolved without traveling to remote gates

10.24.3 Preconditions

SSH access configured; remote desktop setup; monitoring tools deployed

10.24.4 Postconditions

Remote access functional from Old HQ; troubleshooting successful; site visits reduced

10.24.5 Test Cases

Id	Description	Weight
INFRA-REMOTE-TC-001	Configure SSH access from Old HQ to all gates	High
INFRA-REMOTE-TC-002	Configure remote desktop access	High
INFRA-REMOTE-TC-003	Deploy system monitoring tools	High
INFRA-REMOTE-TC-004	Test remote troubleshooting procedures	High

10.25 Ft Infra Maint Spares

10.25.1 Priority

Must Have

10.25.2 User Story

As an IT manager, I want to maintain 10% spare parts buffer so that failed components can be quickly replaced

10.25.3 Preconditions

Spare parts inventory defined; storage at Old HQ prepared; procurement completed

10.25.4 Postconditions

Spare parts available; inventory tracking system in place; replacement procedures documented

10.25.5 Test Cases

Id	Description	Weight
INFRA-SPARE-TC-001	Procure and stock 2x spare NUCs at Old HQ	High
INFRA-SPARE-TC-002	Stock spare hard drives, power supplies, cables	High
INFRA-SPARE-TC-003	Create inventory tracking system	Medium
INFRA-SPARE-TC-004	Test component replacement procedures	High

10.26 Ft Infra Maint Training

10.26.1 Priority

Must Have

10.26.2 User Story

As an IT manager, I want to train local staff on basic hardware maintenance so that first-level troubleshooting is enabled at gates

10.26.3 Preconditions

Training materials prepared; laminated quick reference guides created; trainer identified

10.26.4 Postconditions

Staff trained on restart procedures, basic troubleshooting, escalation; confidence verified

10.26.5 Test Cases

Id	Description	Weight
INFRA-TRAIN-TC-001	Create training materials and quick reference guides	High

Id	Description	Weight
INFRA-TRAIN-TC-002	Train staff on system restart procedures	High
INFRA-TRAIN-TC-003	Train staff on basic network troubleshooting	High
INFRA-TRAIN-TC-004	Train staff on when to escalate issues	High
INFRA-TRAIN-TC-005	Verify staff confidence through practical tests	Medium

10.27 Ft Infra Env Dust

10.27.1 Priority

Must Have

10.27.2 User Story

As an IT administrator, I want to protect hardware from dust in conservation area so that premature hardware failure is prevented

10.27.3 Preconditions

Dust protection strategy documented; enclosed racks or cabinets procured; cleaning schedule prepared

10.27.4 Postconditions

Hardware protected from dust; cleaning schedule implemented; filter maintenance routine

10.27.5 Test Cases

Id	Description	Weight
INFRA-ENV-TC-001	Install enclosed racks or cabinets at each gate	High
INFRA-ENV-TC-002	Install dust filters on equipment	High

Id	Description	Weight
INFRA-ENV-TC-003	Implement regular cleaning schedule	High
INFRA-ENV-TC-004	Verify passive cooling adequate in enclosed racks	Medium

10.28 Ft Infra Env Heat

10.28.1 Priority

Must Have

10.28.2 User Story

As an IT administrator, I want hardware to operate in high temperatures so that reliability is maintained in hot climate

10.28.3 Preconditions

Hardware temperature ratings verified (0-40°C); ventilation designed; monitoring configured

10.28.4 Postconditions

Hardware operates reliably in high temperatures; temperature monitoring active; cooling adequate

10.28.5 Test Cases

Id	Description	Weight
INFRA-ENV-TC-005	Verify hardware rated for 0-40°C operation	High
INFRA-ENV-TC-006	Ensure adequate ventilation in equipment racks	High
INFRA-ENV-TC-007	Configure temperature monitoring and alerts	High
INFRA-ENV-TC-008	Test hardware operation in peak temperatures	Medium

10.29 Ft Infra Env Weather

10.29.1 Priority

Must Have

10.29.2 User Story

As an IT administrator, I want to protect outdoor equipment from weather so that WiFi and camera reliability is maintained

10.29.3 Preconditions

Weather-resistant enclosures procured; IP65+ rated equipment selected; lightning protection planned

10.29.4 Postconditions

Outdoor equipment protected; weather reliability verified; lightning protection installed

10.29.5 Test Cases

Id	Description	Weight
INFRA-ENV-TC-009	Install weather-resistant enclosures for outdoor equipment	High
INFRA-ENV-TC-010	Verify IP65+ rating on outdoor devices	High
INFRA-ENV-TC-011	Install lightning protection for antennas	Medium
INFRA-ENV-TC-012	Test equipment operation in rain/dust conditions	Medium

10.30 Ft Infra Cost Budget

10.30.1 Priority

Must Have

10.30.2 User Story

As a project manager, I want to deliver project within ~\$22,600 budget for 9 gates so that financial constraints are met while achieving goals

10.30.3 Preconditions

Detailed budget prepared; procurement strategy defined; vendor quotes obtained

10.30.4 Postconditions

Project delivered within budget; cost tracking complete; savings documented

10.30.5 Test Cases

Id	Description	Weight
INFRA-COST-TC-001	Create detailed budget breakdown per gate	High
INFRA-COST-TC-002	Track procurement costs against budget	High
INFRA-COST-TC-003	Identify and document cost savings opportunities	Medium
INFRA-COST-TC-004	Verify final project cost \leq \$22,600	High

10.31 Ft Infra Cost Tracking

10.31.1 Priority

Must Have

10.31.2 User Story

As a project manager, I want to track costs per gate during procurement so that budget compliance is ensured and cost savings are identified

10.31.3 Preconditions

Cost tracking spreadsheet prepared; procurement processes defined; approval workflow established

10.31.4 Postconditions

All costs tracked; budget compliance verified; cost savings identified and realized

10.31.5 Test Cases

Id	Description	Weight
INFRA-COST-TC-005	Create cost tracking spreadsheet for all gates	High
INFRA-COST-TC-006	Track bulk purchase discounts achieved	Medium
INFRA-COST-TC-007	Compare local vs international procurement costs	Medium
INFRA-COST-TC-008	Report budget status weekly during procurement	Medium

10.32 Ft Infra Cost Tco

10.32.1 Priority

Should Have

10.32.2 User Story

As a financial manager, I want to calculate total cost of ownership including maintenance so that ongoing operational costs are planned

10.32.3 Preconditions

TCO model prepared; maintenance cost estimates gathered; replacement cycle defined

10.32.4 Postconditions

TCO calculated; ongoing costs budgeted; 5-year financial plan prepared

10.32.5 Test Cases

Id	Description	Weight
INFRA-COST-TC-009	Calculate initial hardware costs (\$22,600)	Medium
INFRA-COST-TC-010	Estimate annual maintenance costs (~\$2,000/year)	Medium
INFRA-COST-TC-011	Plan UPS battery replacement costs (~\$150/year per gate)	Medium
INFRA-COST-TC-012	Create 5-year TCO model with replacement cycle	Medium



11 Additional Context

11.1 Cost Breakdown Per Gate

11.1.1 Intel Nuc

\$300

11.1.2 Nas 4Bay

\$700

11.1.3 Hdds 2X2Tb

\$150

11.1.4 Wifi Ap

\$175

11.1.5 Desktop Pc

\$350

11.1.6 Tablet

\$200

11.1.7 Network Switch

\$40

11.1.8 Ups 1000Va

\$175

11.1.9 Barcode Scanner

\$75



11.1.10 Cables Usb Drives

\$50

11.1.11 Subtotal Per Gate

\$2,215

11.2 Total Project Cost

11.2.1 Nine Gates

\$19,935 ($9 \times \$2,215$)

11.2.2 Spare Nucs 2Units

\$600

11.2.3 Spare Parts 10Percent

\$2,000

11.2.4 Total Hardware

\$22,535

11.2.5 Cameras 15Units

\$3,000-4,500 (not included in base)

11.2.6 Grand Total

\$22,600 base + cameras if needed

11.3 Success Metrics

11.3.1 Hardware Uptime

$\geq 99.5\%$

11.3.2 Ups Runtime

2-4 hours verified at all gates

11.3.3 Deployment On Budget

\$22,600 or less for 9 gates base infrastructure

11.3.4 Deployment On Time

All 9 gates operational within 22 weeks

11.3.5 Staff Satisfaction

≥ 90% staff satisfaction with hardware reliability and performance

