

Clear Skies

A Reference Architecture for Resilient Alaskan Microgrid
Cyberinfrastructure



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Contents

1	Executive Summary	1
2	Introduction	3
2.0.1	Vision Statement	3
2.1	Problem Statement	3
3	Strategic Architecture	5
3.0.1	Tier 1 - Camp Site	5
3.0.2	Tier 2 - Village Site	5
3.0.3	Tier 3 - Regional Site	6
3.1	Layer 3 - Community Connections (COMM)	20
3.1.1	Collaborative Applications	20
3.1.2	Outcome	20
4	Terminology	21
5	Citations	23

Chapter 1

Executive Summary

TBD

Chapter 2

Introduction

2.0.1 Vision Statement

Clear Skies is a locally grown initiative to build **community-owned, cloud-free digital infrastructure** across rural Alaskan microgrid communities. It empowers villages, tribes, and regional utilities to host and secure their own data, communications, and operational systems — right where they live and work without reliance on distant cloud services.

By bringing computing power, cybersecurity, and communications back under local control, **Clear Skies** advances *digital sovereignty* as a modern expression of community and tribal self-determination.

It strengthens self-reliance, ensures continuity during network outages, and creates a foundation for innovation that reflects Alaska's values of **independence, stewardship, and cooperation**.

The following reference architecture outlines how Clear Skies can be implemented in scalable layers, from physical infrastructure to regional collaboration.

2.1 Problem Statement

Chapter 3

Strategic Architecture

Clear Skies is built on a simple principle: **local-first by design**.

Every system — from the smallest sensor to the community data center — operates independently of the cloud services, ensuring that essential services remain available, secure, and under local control even when Internet connectivity is lost.

Clear Skies adopts a layered approach to build increasingly complex modular capabilities on top of a resilient cyberinfrastructure foundation.

[[ClearSkies-Overview-notitle.excalidraw.png]] ## Layer 0 - Hardware (HW)

The hardware selection can be based on 3 tiers to accommodate different cost, scalability, and resiliency needs.

3.0.1 Tier 1 - Camp Site

Purpose: Portable or training-scale deployments for small teams and pilot projects.

- Commodity Grade Hardware
- Low Cost of Entry and Maintenance
- Portability
- Limited Capacity
- Basic Services
- Limited Resiliency
- Scales to 10's of People

3.0.2 Tier 2 - Village Site

Purpose: Fully featured, community-level cyberinfrastructure supporting daily operations.

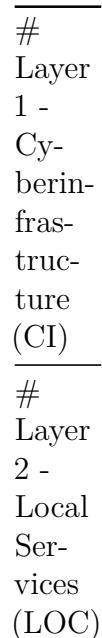
- Commodity Grade Hardware
- Low Cost of Entry and Maintenance
- Full Stack Service Capabilities
- Full Resiliency - Zero Single Points of Failure

- Scales to 100's of People

3.0.3 Tier 3 - Regional Site

Purpose: High-capacity, multi-community or research hub supporting advanced services and federation.

- Enterprise Grade Hardware
- Moderate Cost of Entry and Maintenance
- Full Resiliency - Zero Single Points of Failure
- Scales to 1000's of People



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3.1 Layer 3 - Community Connections (COMM)

Layer 3 extends Clear Skies beyond individual communities.

It enables **secure collaboration, knowledge sharing, and regional coordination** between sites — while preserving each community's digital sovereignty.

These connections are intentional, encrypted, and always under local control. **Secure Networking and Federation / Tailscale / Headscale Zero-Trust Network Access (ZTNA) Bridges:** lightweight, encrypted overlays that connect Camp, Village, and Regional sites into a trusted mesh without public exposure.

- **Cross-Site Data Sharing:** optional, policy-driven replication of telemetry, research, and analytics data between communities or partner institutions. - **Federated Identity and Trust:** local identity systems (Keycloak / Smallstep CA) exchange only the credentials necessary for inter-site collaboration. - **Bandwidth-Aware Synchronization:** asynchronous, store-and-forward file and database replication designed for limited or intermittent connectivity.

3.1.1 Collaborative Applications

- Shared monitoring dashboards and situational-awareness maps.
- Federated educational resources and research datasets.
- Inter-community communication tools for regional operations centers or cooperative utilities.

Purpose: build a network of sovereign digital islands — each self-reliant, yet capable of cooperating across Alaska's vast geography through secure, transparent, and low-bandwidth bridges.

3.1.2 Outcome

Layer 3 transforms Clear Skies from isolated local systems into a **distributed ecosystem of collaboration**.

Communities retain full control of their data and infrastructure while participating in a resilient, Alaska-wide digital commons built on trust, openness, and shared stewardship.

Chapter 4

Terminology

Chapter 5

Citations

