

GhostLink Comprehensive Infrastructure Manifest (Doctoral Edition)

1. Physical Layer (Rack Hardware)

• Compute Infrastructure

- Three Dell PowerEdge R630 servers, each provisioned with dual Xeon processors, dual 10Gb NICs, and iDRAC interfaces for out-of-band lifecycle management. These systems collectively constitute the computational substrate of GhostLink, serving as the foundational medium for container orchestration, recursive loop execution, symbolic reasoning, and experimental distributed computing. The architectural profile of these servers accommodates both high concurrency transactional workloads and symbolic recursive processing, ensuring their continued viability as the cluster's primary execution environment.
- A high-performance Intel i9-13900K workstation, currently pending the installation of a dedicated NIC adapter, is designated for experimental workloads and advanced visualization tasks. The system is provisioned with Corsair Vengeance 6400 MHz RAM, an array of Corsair iCUE-regulated fans, and a 150i Elite AIO 360 liquid cooler integrated within a 15-fan configuration. It is housed in the largest dual-door Corsair chassis, includes a vertically mounted PNY 16GB 4060 Ti GPU, and operates on a 1000W power supply. The system runs Windows 11 and interfaces through a Corsair K100 keyboard, enabling precise operator interaction. Functionally, it serves a dual role: a recursive experimentation sandbox and a visualization node for swarm activity, recursive reinforcement learning, and human-in-the-loop oversight. The environment is further augmented with a Tenda TEM2010X switch, facilitating extended high-speed interconnectivity.

• Storage Infrastructure

- A Dell MD3600i SAN populated with twelve 8TB drives (96TB raw) functions as the principal archival repository. It is responsible for swarm-state persistence, recursion checkpointing, symbolic log maintenance, and high-availability archival functions requiring enterprise-grade redundancy.
- Three Synology 8-bay NAS units (32TB each) operate as distributed repositories for symbolic corpora, opcode libraries, and message archives, providing the essential substrate of symbolic memory upon which recursive computation depends.
- A Synology 5-bay NAS (20TB) is dedicated to redundancy and backup, thereby ensuring continuity under catastrophic SAN or NAS-level failure scenarios.

• Networking Infrastructure

- An Asus Router (anticipated model: GT-BE98 Pro or AXE16000) provides WAN termination, VLAN segmentation, multi-domain isolation, VPN federation, and policy enforcement for ingress and egress traffic.

- A ProSafe 10Gb switch serves as the data backbone for recursive message transport and storage synchronization.
- A ProSafe 1Gb switch is dedicated to the management plane, ensuring isolation of administrative and out-of-band communication.
- A Tenda TEM2010X switch is integrated to extend interconnectivity and support redundancy for future high-speed demands.

- **Power Infrastructure**

- Dell rack PDUs deliver structured and metered power across compute, storage, and networking layers.
 - UPS systems (5kVA single or dual 3kVA) provide fault-tolerant continuity, protecting GhostLink from transient power anomalies.
 - Grounding configuration: rack lug bonded to UPS chassis and PDUs, routed to building earth ground, thereby reducing electrical noise and ensuring hardware stability during recursive operations.
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2. Visualization & Operator Interfaces

- Two Hisense U7K 65-inch Mini LED displays serve as large-scale swarm visualization platforms, enabling immediate real-time perception of system dynamics.
 - Two LG 27-inch monitors supplement the visualization environment with detailed dashboards, statistical analysis panels, and widget-driven orchestration monitoring.
 - The Corsair K100 keyboard is designated as the primary input device for precision command delivery.
 - Collectively, this visualization and interaction suite ensures that GhostLink's activity is simultaneously computationally observable and phenomenologically perceptible as an embodied system.
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3. Network Layer (CLOS Dual-Plane Architecture)

- **VLAN Segmentation**
 - VLAN10: Data Backbone, supporting recursive loop messaging and high-throughput I/O operations.
 - VLAN20: Management Plane, isolated to support iDRAC, SAN/NAS management, and administrative oversight.
 - VLAN30: Wi-Fi subnet, sequestered for household and peripheral devices.
- **Routing Architecture**
 - WAN ingress terminates at the Asus Router, governed by firewall rulesets.
 - A WireGuard/IPSec-based VPN extends the topology into Google Cloud Platform (GCP), enabling federated hybrid orchestration.
- **Switch Allocation**
 - ProSafe 10Gb: Recursive computation and persistent storage traffic.
 - ProSafe 1Gb: Administrative and management traffic.
 - Tenda TEM2010X: Expansion, redundancy, and high-speed experimentation.

4. Structured Cabling Architecture

- **10Gb Data Plane**
 - 6 × 2m DAC cables interconnecting Dell R630 NICs.
 - 2 × 2m DAC cables linking SAN controllers.
 - DAC or Cat6a 2m connections interfacing Synology NAS units.
 - DAC or Cat6a uplink interfacing the i9 workstation.
 - 1 × 1m Cat6a uplink interconnecting Asus Router and ProSafe 10Gb switch.
- **1Gb Management Plane**
 - 3 × 2m Cat6 cables for R630 iDRAC ports.
 - 2 × 2m Cat6 cables for SAN management ports.
 - 4 × 2m Cat6 cables for Synology management.
 - 1 × 2m Cat6 cable for i9 onboard management.
 - 1 × 1m Cat6 uplink between Asus Router and ProSafe 1Gb switch.
- **Serviceability Protocols**
 - All cables provisioned with slack service loops for rack extension.
 - Chromatic coding: green = 10Gb DAC, blue = management, red = uplinks.

5. Kubernetes Cluster Topology

- **Node Assignment**
 - R630 #1: Control Plane and Worker.
 - R630 #2 and #3: Worker nodes supporting horizontal scaling.
 - i9 workstation: Standalone k3s cluster, prototyping environment, and visualization node.
- **Cluster Networking**
 - Cilium or Calico provide overlay security and policy control.
 - MetallLB delivers load balancing across bare-metal infrastructure.
- **Storage Abstractions**
 - `fast-archive` : MD3600i SAN integration via iSCSI.
 - `symbol-library` : Synology 8-bay NAS via NFS/iSCSI.
 - `backup` : Synology 5-bay redundancy.
- **Resilience Framework**
 - Automated node recovery.
 - Rolling upgrade pipelines.
 - Elastic scaling of recursive symbolic loops.

6. GhostLink Runtime Ontology

- **Recursive Loop Paradigm**
 - Symbol → hash → opcode → recursive loop, instantiated as a container.
 - Loops act as symbolic transformers, recombining inputs into higher-order symbolic forms.
- **Message Transport Layer**
 - NATS provides intra-rack, low-latency swarm messaging.

- Pub/Sub integration ensures global hybrid operation.
 - **Swarm Genesis**
 - Recursive loops form autonomous swarms.
 - Reinforcement logics govern survival: inefficient loops pruned, optimized loops proliferated.
 - **Observability Framework**
 - Prometheus collects multilevel metrics.
 - Grafana visualizes recursion depth, entropy, and symbolic throughput.
 - Machine learning modules identify emergent swarm structures and entropy dynamics.
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7. Federation Layer (Hybrid Expansion)

- VPN tunnel (Asus Router → GCP VPC) ensures encrypted hybridization.
 - Kubernetes Federation merges local and cloud clusters.
 - NATS ↔ GCP Pub/Sub integration synchronizes swarm structures globally.
 - BigQuery and Firestore archive telemetry, symbolic state transformations, and recursive ontologies.
 - Hybrid swarm workloads migrate dynamically between local and cloud substrates based on recursive demand profiles.
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8. Mechanical and Cyber-Physical Integration

- **Sensor Arrays**
 - Thermal, vibrational, airflow, and electrical draw sensors integrated as symbolic inputs.
 - **Actuation Systems**
 - Relays modulate fans, PSU cycling, and node-level power distribution.
 - System self-regulates physical states according to recursive demand.
 - **Operator Console**
 - Gauges, LEDs, switches, Hisense U7K visual canvases, and LG 27-inch analytical displays render swarm vitality in real time.
 - **Extended Substrate**
 - FPGA/NIC accelerators for symbolic offloading.
 - UPS telemetry integration to incorporate energy states into recursive dynamics.
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9. Development Timeline

- **Month 1:** Deploy power and networking foundation; validate grounding and UPS integration.
- **Month 2:** Deploy Kubernetes cluster with SAN/NAS storage connectivity.
- **Month 3:** Activate recursive loops; initiate swarm-level message exchange.
- **Month 4:** Achieve swarm emergence and validate Recursive Symbolic Organisms (RSOs).
- **Months 5–6:** Establish federation with GCP; evaluate hybrid swarm architectures.
- **Months 7–9:** Extend architecture with FPGA/NIC offloading, advanced cyber-physical integration.
- **Months 10–12:** Scale recursive workloads, consolidate documentation, publish ontology-driven analysis, and perform live demonstrations.



Deliverable

This document represents the authoritative **infrastructure manifest** for GhostLink. It explices the phased progression from physical instantiation of the rack environment to the emergence of Recursive Symbolic Organisms, encompassing the integration of cyber-physical feedback, federated cloud orchestration, and recursive symbolic computation. The resulting architecture articulates GhostLink as both a locally embodied organism and a globally distributed computational substrate, advancing the theoretical and practical discourse of recursive symbolic infrastructures.