Tunnel View Project - Azure Infrastructure and Data Processing Architecture

1. Tools and Components Used in the Architecture

On-Premise Components (MTA On-Premises)

- Ladybug Camera: Captures tunnel segment images.
- Internal Users: Upload image files and LDS dialog metadata.
- Upload Path: Uses Azure ExpressRoute for secure, private upload.

Network and Connectivity

- Azure ExpressRoute: Enables secure and low-latency private connection.
- ExpressRoute Gateway & Subnet: Connects Azure VNet with on-premises.
- Private Endpoints: Secure service access (Blob, File, etc.).

Azure Virtual Network (VNet) Setup

- Azure Virtual Machines: High-performance VMs running Python scripts.
- Subnet: Logical segmentation.
- Availability Zone: Optional high availability.

Storage Solutions

- Azure Blob Storage: Stores raw and processed image data.
- Azure File Share: Optional intermediate file sharing layer.
- Archive Blob Storage: Long-term retention for up to 1 year.

Additional Tools

- Python Tools & Scripts: Image processing and automation.
- ESRI GIS Enterprise: Visualization and GIS mapping of outputs.

- Azure Monitor & Log Analytics: Infrastructure monitoring.

2. Data & Processing Flow

1. Data Capture & Upload

- Ladybug camera captures images.

- Internal users upload LDS and plan files.

- Uploads via ExpressRoute to Azure.

2. Transmission

- Data moves through MTA Gateway to Azure Gateway via ExpressRoute.

3. Data Processing

- Azure VMs run Python scripts.

- Weekly batch processing (~30GB/day).

4. Data Storage

- Raw and processed data stored in Blob/File/Archive Storage.

5. Data Consumption

- Accessed via private endpoints by ESRI GIS or internal portals.

3. Why Each Component Is Used

Ladybug Camera: High-res image capture.

ExpressRoute: Secure upload path.

Private Endpoints: No public exposure.

VMs: For compute-intensive Python processing.

Blob Storage: Scalable object storage.

File Share: For shared filesystem needs.

Archive Storage: Cost-effective long-term storage.

Monitor: System visibility and alerts.

4. Operational Considerations

Cost Optimization: Auto VM provisioning, Archive tier.

Security: Private endpoints, reuse access roles.

Automation: VM lifecycle scripting.

Scalability: Handles growing image data volume.

5. Architecture Summary

Image Volume: 900GB/month, 30GB/day

Processing: Weekly batch

Tools: Python, Azure Blob/File, ExpressRoute, VMs

Security: Firewall + private endpoints

Monitoring: Azure Monitor, Log Analytics

Access: APIs, portals, blob access

Performance: SSD-backed high-vCPU VMs

GIS: ESRI integration for visualization