# Highway Operations Use Case

*Unified control center integrating 11 subsystems with 413,000+ tags and 1,600+ cameras.*
*Industry: Transportation / Infrastructure*

## Quick Facts

| Attribute | Value |
|---|---|
| **Customer** | Major highway concessionaire — toll road operator |
| **Scale** | 413,882 tags, 85,400 communication points, 1,605 cameras |
| **Subsystems** | 11 integrated (ventilation, traffic, toll, cameras, HVAC, utilities, emergency, signage, access, PA) |
| **Architecture** | Dual-server redundancy, 7 protocols, 56 channels |
| **Displays** | 261 operator screens |
| **Status** | 24x7 continuous operation |

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## The Challenge

**Challenge:** Integrate 11 critical highway subsystems into a unified operations center with real-time monitoring, coordinated response, and high availability for safety-critical infrastructure.

**Specific pain points:**

- Fragmented control systems preventing unified operational view
- Manual coordination between different subsystems causing response delays
- Lack of centralized monitoring for safety-critical systems across the highway
- Inability to respond quickly to incidents or emergencies
- Multiple protocols and equipment types requiring integration

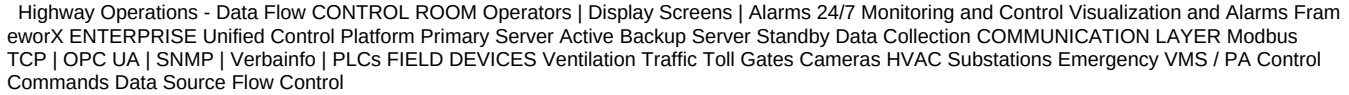
**Impact:** Increased incident response times, higher operational costs due to multiple control rooms, safety risks from uncoordinated subsystem responses, and reduced highway capacity during emergencies.

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## The Solution

### Architecture

| Tier | Component | Capabilities |
|---|---|---|
| **Central** | FrameworX Enterprise (dual-server) | Unified platform, 11 subsystems, 24x7 operation, unlimited clients |
| **Field** | 19 Altus PLCs + cameras + subsystems | Distributed control across highway infrastructure |
| **Clients** | 261 operator displays | Real-time monitoring and control |




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### Scale

| Metric | Value |
|---|---|
| Total Tags | 413,882 |
| Communication Points | 85,400 |
| Integrated Cameras | 1,605 (organized in 83 groups) |

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|---|---|
| Operator Screens | 261 displays |
| Active Alarms | 71,833 |
| Protocols | 7 across 56 channels |
| Running Scripts/Tasks | 26 |
| PLCs | 19 Altus controllers |
| Concurrent Users | Average 10 operators (unlimited license) |

### Connectivity

| Protocol | Application |
|---|---|
| Modbus TCP | PLCs, field devices |
| OPC UA | System integration |
| SNMP | Network equipment, cameras |
| Verbainfo | Specialized highway systems |
| Others | 3 additional protocols |

### Integrated Subsystems

| Subsystem | Function |
|---|---|
| **Ventilation Control** | Tunnel air quality and flow management |
| **Traffic Management** | Semaphore control and traffic flow optimization |
| **Toll Operations** | Gate control and transaction monitoring |
| **Video Surveillance** | 1,605 cameras with group management |
| **HVAC Systems** | Environmental control for facilities |
| **Utilities Management** | Treatment stations and electrical substations |
| **Emergency Systems** | Emergency phones and response coordination |
| **Information Systems** | Variable message signs (PMV) for driver information |
| **Access Control** | Security throughout the highway |
| **PA Systems** | Public address and emergency announcements |
| **Electrical Substations** | Power distribution monitoring |

### Redundancy & Failover

**Servers:**

- Dual-server architecture (primary/backup)
- 100% availability for critical infrastructure
- Automatic failover

**Operations:**

- 24x7 continuous operation
- Unlimited client connections
- Real-time performance across all subsystems

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## Key Enablers

*FrameworX capabilities that made this solution possible:*

| Capability | Application |
|---|---|

| | |
|---|---|
| **Massive Tag Management** | Handling 413,882 tags with real-time performance across distributed systems |
| **Multi-Protocol Support** | Native integration of 7 protocols (Modbus TCP, OPC UA, SNMP, Verbainfo) through 56 channels |
| **Enterprise Redundancy** | Dual-server architecture ensuring 100% availability for critical infrastructure |
| **Scalable Visualization** | Supporting 261 operator screens with unlimited client connections |
| **Advanced Alarm Management** | Processing and prioritizing 71,833 alarms across all subsystems |
| **Camera Integration** | 1,605 cameras organized in 83 groups with unified management |

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## Strategic Insights

**Subsystem Unification**

Traditional highway operations use separate control systems for each subsystem — traffic, ventilation, toll, cameras. This creates coordination delays during incidents. A unified platform enables automated cross-subsystem responses: tunnel incident triggers ventilation, variable signs, and emergency notifications simultaneously.

**Scale Without Complexity**

400k+ tags across 11 subsystems could require multiple specialized platforms. Native multi-protocol support (7 protocols, 56 channels) enables single-platform integration without middleware layers or protocol converters.

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## Results

- **Unified Highway Operations** — Successfully integrated 11 critical subsystems into a single control platform, eliminating fragmented operations and enabling centralized monitoring across the entire highway infrastructure
- **Massive Scale Integration** — Deployed system handling 413,882 tags, 1,605 cameras, and 85,400 communication points with 100% uptime through dual-server redundancy architecture
- **Enhanced Response Capabilities** — Reduced incident response times through coordinated subsystem control, real-time alarm management of 71,833 active alarms, and seamless operator access across 261 displays
- **Operational Efficiency** — Achieved 24x7 continuous operation with average 10 concurrent operators, supporting unlimited client connections while maintaining real-time performance across all integrated systems

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*This case demonstrates large-scale infrastructure operations with multi-subsystem integration, massive tag counts, and enterprise redundancy for safety-critical highway management.*