

Carrier-Grade Infrastructure Solution Brief: Deploying Smart City Surveillance Network Architecture Design

CARRIER-GRADE INFRASTRUCTURE SOLUTION BRIEF: DEPLOYING SMART CITY SURVEILLANCE NETWORK ARCHITECTURE DESIGN

MARKET POSITIONING

As global urbanization accelerates, municipalities and system integrators face a singular imperative: deploy surveillance networks that guarantee 99.999% availability, sub-50ms failover, and deterministic latency for real-time analytics. The Smart City Surveillance Network Architecture Design addresses these demands through a purpose-built, carrier-grade infrastructure stack that unifies edge acquisition, aggregation, and core transport. Unlike best-effort enterprise switches, this architecture is engineered for continuous operation in uncontrolled roadside cabinets, high-EMI intersections, and thermally challenging environments. Compliance with NG911, GDPR video safeguards, and NIST 800-167 encryption mandates is embedded from the physical layer upward.



HIGH-AVAILABILITY REDUNDANCY

Resilience distinguishes municipal surveillance from commercial IT. The reference design implements ITU-T G.8032 Ethernet Ring Protection Switching with sub-50ms reconvergence across all aggregation nodes. For core-to-edge paths, Multi-Chassis Link Aggregation (MC-LAG) eliminates split-brain scenarios while delivering 1:1 active-active uplinks. Power architecture follows Telcordia GR-3160 standards: dual -48 VDC hot-swappable rectifiers with 5-second holdover and automatic transfer to N+1 battery strings. Every field-deployable node incorporates 1+1 redundant field-replaceable fan trays rated for 150,000 hours MTBF (MIL-HDBK-217F, ground fixed conditions). Failure domains are isolated via redundant fabric modules and separate control plane CPUs running Hitless Restart (NSF/SSO).

PROTOCOL INTEROPERABILITY

To preserve investment in existing city infrastructure, the architecture unconditionally supports multi-vendor interoperability at Layer 2 and Layer 3.

Core protocols include:

- Switching: IEEE 802.1Q VLAN, Q-in-Q, MSTP/RSTP, and G.8032 v2.
- Routing: OSPFv2/v3, BGP-4, IS-IS for massive scale, and static routes for hardened edge.
- Multicast: IGMP v2/v3 snooping, PIM-SM for video distribution.
- Management: NETCONF/YANG, SNMP v3 (AES-256), RESTCONF, and streaming telemetry via gNMI.
- Security: MACsec (IEEE 802.1AE) on all trunk ports, control plane policing (CoPP), and RADIUS/TACACS+ for AAA.

All protocol implementations have passed MEF 3.0, ONF OpenFlow 1.5, and IETF interoperability plugfests.

DETAILED PARAMETERS

Switching Fabric Architecture: Fully non-blocking, cell-based Clos fabric with per-port virtual output queuing (VoQ). Maximum forwarding rate: 1.44 Bpps (for 10-port 100GE line card configuration).

Forwarding Modes: Cut-through (configurable per port) with 950 ns typical latency; store-and-forward for jitter-sensitive streams.

Jumbo Frames: 9216 bytes (standard), 16384 bytes (optional licensing for forensic storage).

Traffic Policing: Dual-rate three-color marker (RFC 2698) with 1 Kbps granularity; 1024 queues per egress port supporting SP, WRR, and DRR scheduling.

MAC Address Table: 512K entries.

IPv4/IPv6 Routes: 1M FIB entries (hardware), 2M RIB entries.

Parameter	Specification
Form Factor	3RU Modular Chassis (Aggregation Core) / 1RU Fanless (Edge Node)
Switching Capacity	6.4 Tbps (Aggregation) / 320 Gbps (Edge) Non-blocking
Power Supply	1+1 Redundant, -48 VDC or 100-240 VAC auto-ranging, 800W/150W modules

Operating Temperature	-40°C to +75°C (Edge), 0°C to 50°C (Core Datacenter)
Packet Buffer	32 MB shared (Aggregation), 4 MB (Edge)
Latency (64-byte)	1.2 µs (Aggregation), 2.1 µs (Edge)
MACsec Encryption	256-bit GCM, line rate on all ports
Ring Protection	ITU-T G.8032 v2, sub-50ms switchover
MTBF (System)	340,000 hours (Telcordia SR-332)

LIFECYCLE ASSURANCE (MTBF)

All active components undergo 168-hour burn-in at 75°C ambient. System-level MTBF (field-replaceable units aggregated) is 340,000 hours calculated per Telcordia SR-332 Issue 4, Method 1, Case 3. Mean Time To Repair (MTTR) is 2 hours for line cards and 30 minutes for power supplies using hot-swap procedures. Recommended spares kit for a 500-camera deployment: 3x power modules, 2x fan trays, and 1x fabric module. Environmental stress screening (ESS) includes 12 thermal cycles (-40°C to +85°C, 10°C/min ramp) and 20g mechanical shock per IEC 60068-2-27.

TARGET NETWORK TOPOLOGIES

The architecture scales from metropolitan districts (100–500 cameras) to entire smart regions (50,000+ endpoints). Verified reference topologies:

1. Star-of-Rings: Core ring connects three aggregation zones, each zone comprising G.8032 rings for neighborhoods. Optimal for geographic redundancy.
2. Leaf-Spine for High Density: 4x 100GE spine switches, 32x 25GE leafs at intersections. Supports 2000 4K cameras at 15 Mbps each.
3. Extended Daisy-Chain with Redundant Portal: For linear infrastructure (highways, riverways), dual-homed end nodes ensure path protection.

Maximum scale per core cluster: 128 aggregation switches, 4096 edge switches, 65,536 camera endpoints.

