



Mobile Optical Pluggables Alliance (MOPA)

Market Outlook

Architecting the Mobile Optical Future (2025–2031)

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1. Executive summary - The Optical Foundation of Connected Intelligence

MOPA aims to develop a shared and common view of the optical solutions needed for mobile transport [MOPA].

MOPA's shared and common view of the optical solutions needed for mobile transport are contained in three Technical Papers:

- **Requirements & Blueprints [MOPA-BP]:** General functional requirements, and mobile optical blueprints for C-RAN, D-RAN and vRAN, based on available technologies.
- **New Technologies [MOPA-NT]:** Relevant emerging and future technologies that could be included in the blueprints.
- **Market Outlook [MOPA-MO]:** The market outlook for optical solutions in the context of mobile networks. This paper.

In the architecture of next-generation connectivity, the optical layer has transitioned from a passive support component to the primary foundational enabler of the mobile ecosystem. As the industry pivots toward 5G-Advanced and defines the roadmap for 6G, the performance of optical pluggables has become a critical determinant of network competitiveness and service differentiation. This market outlook identifies a robust return to growth in the mobile optical transport sector, fueled by a fundamental shift in data traffic patterns and a strategic realignment of infrastructure investment. While legacy metrics focused on raw volume, the 2025–2031 window will be defined by an operator's ability to translate high-capacity transport into differentiated, high-margin revenue streams.

Strategic Snapshot

- **5G Subscription Scale:** Global 5G subscriptions are projected to reach 2.9 billion by year-end 2025, accounting for approximately one-third of the global total.
- **Traffic Trajectory:** Mobile network data traffic continues to grow at a stable 20% annual rate (Q3 2024–Q3 2025), driven by 5G's increasing dominance.
- **The AI Uplink Surge:** The convergence of cloud-assisted AI and mobile will trigger a 3x to 5x increase in uplink capacity requirements, with the most direct impact on fronthaul bandwidth. Due to significantly higher uplink coding overhead compared to downlink in the fronthaul (low-layer split), uplink capacity is a more binding constraint at this interface; mid-haul and backhaul interfaces, where coding gain is lower, also see traffic growth but have more headroom to accommodate it.



- **FWA as a Growth Catalyst:** By 2031, Fixed Wireless Access (FWA) will serve 1.4 billion people, representing 36% of all mobile network data traffic and necessitating dense, high-capacity backhaul.

This shifting landscape necessitates a fundamental evolution of the optical transport layer, as raw volume without spectral efficiency represents an operational liability in the era of Connected Intelligence.



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2. The Strategic Inflection Point: AI and the Uplink Revolution

The window between 2025 and 2031 represents a definitive shift in network investment priorities. While previous investment cycles prioritized downlink capacity for content consumption, the emergence of Generative AI is catalyzing an “Uplink Revolution.” Cloud-assisted AI applications—such as a technician using real-time video for engine repair—demand high-quality, high-bandwidth video uplink to offload heavy processing from the device to the cloud. This trend alone necessitates a 3x to 5x increase in capacity on the optical plug to maintain performance and device battery longevity.

It is important to note that this 3x to 5x capacity increase primarily impacts fronthaul interfaces. In fronthaul (low-layer split, eCPRI/CPRI), the uplink carries significantly more overhead due to coding, forward error correction (FEC), and retransmissions compared to downlink. As a result, the already-limited headroom in the fronthaul uplink becomes a critical constraint as AI-driven traffic grows. At mid-haul and backhaul interfaces, where much of the lower-layer processing has already occurred, the ratio of uplink-to-downlink overhead is less pronounced, and these interfaces retain more capacity headroom—though they will also see proportional traffic growth driven by increased net user data volumes.

Feature	Traditional Traffic Drivers	AI-Native & Uplink-Heavy Drivers
Primary Use Case	Video Streaming & Browsing	Cloud-Assisted AI, Digital Twinning, AR
Data Flow	Asymmetric (Downlink-Heavy)	Symmetric or Uplink-Intensive
Monetization Model	Volume-based (Data Buckets)	Experience-based / SLA-backed
Network Demand	High Peak Rates (eMBB)	High QoS & Timing Precision (URLLC)

These demands dictate that the optical infrastructure must evolve well ahead of the 6G commercial launch in 2030 to prevent transport from becoming a bottleneck for high-value services.



3. Market Metrics & Subscription Trajectories (2025–2031)

The mobile optical transport market is returning to growth, underpinned by a shift from simple capacity metrics to sophisticated data requirement and subscription density KPIs. 5G subscriptions are forecasted to reach 6.4 billion by 2031, with 5G Standalone (SA) representing the critical architectural prerequisite for value creation. Projected to account for 65% of all 5G subscriptions (4.1 billion) by 2031, 5G SA allows operators to shift the conversation from “data quantity to data differentiation.”

The Singtel case study [SINGTEL] illustrates this transition: by utilizing 5G SA and differentiated connectivity, the operator has moved toward “experience as a currency,” offering tiered packages (5G+, 5G+ Enhanced, 5G+ Priority) that provide guaranteed performance and security. This model is essential for monetizing the \$127 billion global investment in mobile internet connectivity. Furthermore, the massive scale of FWA—projected to handle 174 EB of monthly traffic by 2031—requires a transition to high-density optical hardware capable of supporting fixed-line traffic volumes on a mobile footprint.



4. Technology Trajectory: Scaling to 50G and the Roadmap to 6G

Optical standardization must strategically precede radio specifications by several years to ensure hardware readiness for 6G platforms. The industry has reached the “50G Inflection Point,” a strategic response to 5G-Advanced and advanced Massive MIMO requirements. 50G module shipments for fronthaul are on track to reach 10 million units annually by 2030, while 50G DWDM modules for midhaul are expected to scale from tens of thousands to hundreds of thousands by 2030.

Mobile Transport Evolution Roadmap

Network Phase	Strategic Service Category	Line Rate Evolution
5G	eMBB / mMTC	10G → 25G
5G-Advanced	URLLC / Advanced eMBB	25G → 50G
6G (2030 Launch)	AI-Native / Integrated Sensing	50G → 100G

With 6G technology proposals due between 2027 and 2029, MOPA's blueprints must be volume-ready by 2027 to support the 2030 commercial launch. This timeline ensures that the transport layer can support the “extreme experience” and sensing capabilities envisioned for the 2030s.



5. The Monetization of Low-Latency Architectures

Radio Access Network (RAN) architecture selection—Distributed (DRAN), Centralized (CRAN), and Virtualized (vRAN)—is the primary driver of optical procurement.

- **DRAN:** Remains the global volume leader. Its dominance reflects the large installed base of existing deployments and the practical economics for operators who have already built out distributed infrastructure at scale. For greenfield operators, DRAN remains an attractive option for its simplicity and cost-optimized, short-reach solutions. Operators with large installed bases are likely to maintain DRAN as a core component of their network architecture.
- **CRAN & vRAN:** Represent the high-margin segment. While DRAN can support network slicing and URLLC in principle, centralized architectures are significantly better suited to deliver these capabilities at scale. Centralization enables pooling of DU/CU resources, allowing multiplexing gains across multiple radio sites—which in turn lowers per-site costs and enables more efficient resource sharing. Centralized models also facilitate the combination of data from multiple sites, enabling interference cancellation and coordination techniques that are not feasible in a fully distributed architecture. These characteristics make CRAN and vRAN the preferred path for operators targeting premium enterprise revenue, providing the timing precision and minimal latency variation required for industrial IoT and private 5G networks.

The transport layer must support the diverse “languages” of these architectures, primarily eCPRI/CPRI over the Low-Layer Split (LLS) for fronthaul and the 3GPP F1 interface for High-Layer Split (HLS) backhaul.



6. Innovation in Form Factors and Power Efficiency

Form factor standardization (SFP56, QSFP-DD) is vital for supply chain resilience and reducing engineering complexity—a core pillar of Total Cost of Ownership (TCO) optimization.

- **SFP (Small Form-factor Pluggable):** Optimized for Fronthaul, offering 50G rates within existing radio unit space and uncooled outdoor temperature constraints.
- **QSFP / QSFP-DD:** Optimized for Midhaul and Backhaul scalability, enabling dense aggregation.

The business case for Linear Pluggable Optics (LPO) is particularly compelling for OpEx reduction. By removing the Digital Signal Processing (DSP) component, LPO modules achieve a 50% reduction in power consumption. This makes LPO a strategic necessity for uncooled outdoor environments—a major pain point in the Asia-Pacific region—and directly supports corporate sustainability goals by lowering the energy footprint of global base station deployments.



7. Global Economic Outlook and Supply Chain Resilience

The mobile optical transceiver market is projected to experience a 28.15% CAGR, growing from 2025 to 2031. Realizing this growth requires navigating regional priorities and supply chain risks.

- **Asia-Pacific:** The volume leader, anchored by China's 4.76 million 5G base stations, driving global economies of scale.
- **North America:** Focused on Open RAN and the \$65 billion broadband stimulus, which creates unique demand for cost-effective, long-reach standardization to support rural coverage.
- **Europe/Middle East:** Driven by infrastructure modernization and a rigorous focus on energy sustainability and OpEx reduction.

Standardization acts as a vital hedge against supply chain volatility. Historical 4-to-6-month lead times, often caused by bottlenecks in Photonic Integrated Circuits (ICs) and RF components, can be mitigated through MOPA-standardized blueprints. These allow operators to rapidly qualify alternative suppliers, ensuring that deployment schedules remain resilient.



8. Conclusion: MOPA's Role in the 2030 Vision

MOPA serves as the industry's orchestrator, aligning RAN vendors, IC suppliers, and operators to drive the economies of scale necessary for the 6G era. By synchronizing technical requirements, MOPA ensures that the products reaching the market meet real-world deployment needs for power, latency, and capacity.

The 2025–2031 window is a unique opportunity to establish the interoperable foundations for AI-enabled connected intelligence. Adoption of standardized optical blueprints is the only viable path to ensuring hardware readiness for the 2030 vision, turning massive infrastructure investments into the high-margin enterprise revenues of tomorrow.



9. References

[MOPA]	MOPA Alliance. https://mopa-alliance.org
[MOPA-NT]	MOPA Technical Paper – New Technologies
[MOPA-BP]	MOPA Technical Paper – Requirements & Blueprints
[MOPA-MO]	MOPA Market Outlook
[SINGTEL]	Singtel, “5G SA Differentiated Connectivity,” Singtel Investor/Media Publications. Available at: https://www.singtel.com

Note on Market Data Sources:

Market projections and subscription figures cited in this document (5G subscription forecasts, FWA traffic estimates, CAGR figures) are drawn from leading industry analyst reports including Ericsson Mobility Report (Q4 2024), GSMA Intelligence, and Dell’Oro Group op.



10. Acronyms

Acronym	Definition
5G SA	5G Standalone
AR	Augmented Reality
CAGR	Compound Annual Growth Rate
CPRI	Common Public Radio Interface
CRAN	Centralized Radio Access Network
DSP	Digital Signal Processing
DWDM	Dense Wavelength Division Multiplexing
eMBB	Enhanced Mobile Broadband
eCPRI	enhanced Common Public Radio Interface
FDD	Frequency Division Duplex
FEC	Forward Error Correction
FWA	Fixed Wireless Access
HLS	High-Layer Split
IC	Integrated Circuit
IoT	Internet of Things
LLS	Low-Layer Split
LPO	Linear Pluggable Optics
MIMO	Multiple-Input Multiple-Output
mMTC	Massive Machine-Type Communications
MOPA	Mobile Optical Pluggables Alliance
OpEx	Operational Expenditure
QSFP-DD	Quad Small Form-factor Pluggable Double Density
RAN	Radio Access Network
SFP	Small Form-factor Pluggable
SLA	Service Level Agreement
TCO	Total Cost of Ownership
TDD	Time Division Duplex
TTG	TDD Guard Period (Time-slot for Guard)
URLLC	Ultra-Reliable Low-Latency Communications
vRAN	Virtualized Radio Access Network