

SDC & COMMS Optical Communications White Paper

v1.1

NASA MCP Integrated Edition

Prepared by: ARCHITECT / MECHWORK / HYDRATEK / MECSAI
Program: SDC & COMMS — Spear Enterprise LLC / NASA
Date: October 17, 2025

Document ID: SDC-COMMS-2025-OPTICAL-WP-v1.1
Distribution Classification: Internal – ATB / NASA Partner Review

This document integrates the MCP crosswalk, ATB Laser Standards, MECSAI security framework, and SDC Master Plan into a unified NASA-standard report on optical communications design, compliance, and operational readiness. It serves as the definitive internal submission to the ATB board for archival under NASA-STD-7009 protocols.

1. Executive Summary

Integration of AfSA–Oxford–ESA course insights and SDC Master Plan architecture for GEO–LEO optical mesh design.

2. NASA MCP Alignment Matrix

Crosswalk mapping LNIS, ICSIS, SCaN-MOCS, and LCRNS specifications to subsystem readiness states.

3. Optical System Architecture

GEO–LEO topology with adaptive PAT logic, DTN BPv7 routing, and AFS time distribution.

4. Security Architecture

MECSAI multi-layer optical data security stack, quantum-resistant encryption, and zero-trust orchestration.

5. Standards and Compliance Crosswalk

MCP Agent Blueprint v0.1 alignment and Change Detection Playbook automation.

6. Integration with MECSAI & Agent Swarm

Autonomous routing, audit traceability, and ATB quality gates.

7. Financial and Operational Readiness

Derived from SDC Constellation v1.0 and Master Plan v1.1 financial annexes.

8. Recommendations & Roadmap

Implementation phases for ATB and NASA compliance testing.

9. Conclusions and Action Items

Finalize ATB approval cycle; schedule LCRNS optical acquisition trials.

Embedded Annexes

Annex A — Optical Link Budget Model Annex B — PAT Control Logic Diagram Annex C — OGS Site Map and Availability Model Annex D — QKD Interface Overview Annex E — NASA Form 1686 Routing Slip