NSRP | National Shipbuilding Research Program

Fiber Optics and Photonics Trends (what have we learned and what are we about to learn)

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Practical Mission

Transmission of data by photons is theoretically more economical than by electrons.

We turn what has been theoretically proven into
something that is reproducible and reliable.

NAVSEA Fiber Optics

Alongside commercial implementation of fiber optics, NAVSEA was the first consistent and disciplined implementation of fiber optics in military platforms.

Deployment of fiber optics in the Navy continues in concert with widely recognized standards.

Data Traffic in Military Platforms

Characteristics of commercial data:

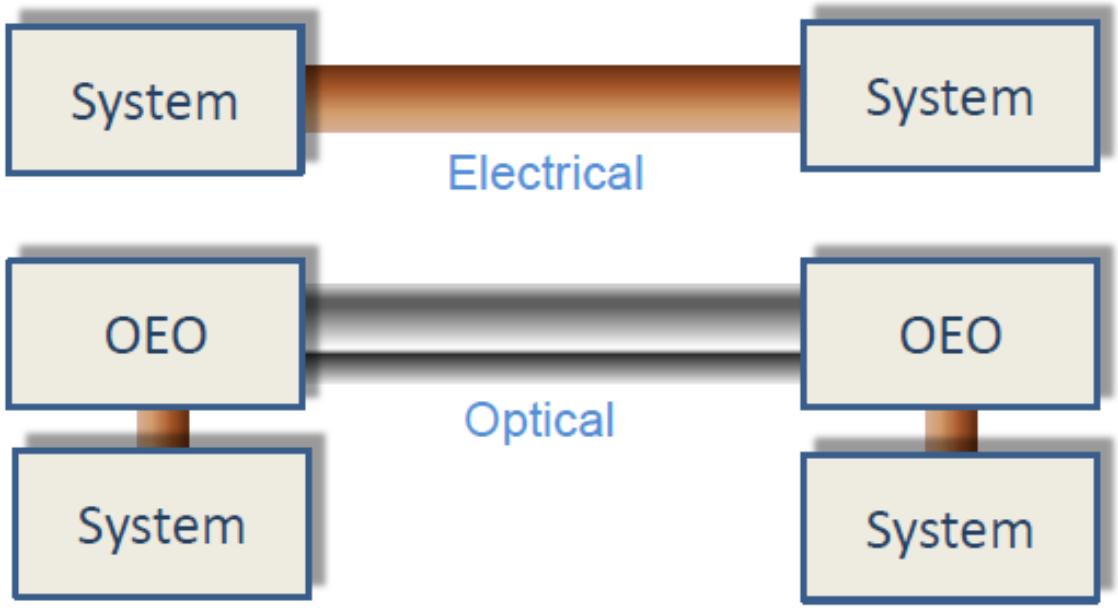
- ❑ transmission between common platforms
- ❑ large variety of sources and destinations

Characteristics of data in military platforms:

- ❑ large variety of platforms and equipment
- ❑ stable structure of sources and destinations

Fiber in Military Platforms

Business Case for Optical Transmission:



(2 x OEO) + Optical Cable < Electrical Cable

NSRP Shipboard Fiber Optic Cables Design Enhancements (2019-477-001)

Fiber Optic Connectors

Assembly, installation, and maintenance of fiber optic connectors in rugged environments has dominated our resources for 30 years.

A fiber optic connector must align fiber cores to submicron tolerances, and maintain the alignment over its lifetime.

NSRP Variant Reduction for Shipboard Installed Connectors (2016-421)

Fusion Splicing

Fusion splicing equipment provides the precision necessary to align optical fiber cores and welds them together permanently.

A splice protector and packaging cheaply to shields the splice from the outside environment.

Fiber connections which do not need frequent access are candidates for fusion splicing.

NSRP Alternatives to Fiber Optic Connectors (2015-442)

Link Inspection

Historically, optical sources and power meters have been used to measure link performance, one fiber at a time.

Optical Time Domain Reflectometry (OTDR) is being considered. Multi-channel OTDR is feasible.

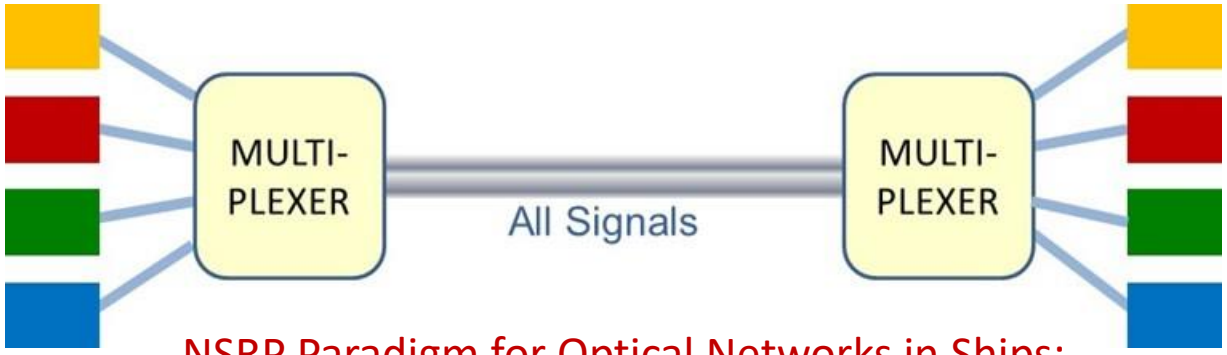
Bit Error Rate (BER) is theoretically related to Signal / Noise Ratio above unity. If so, link loss could possibly be measured without breaking connections.

NSRP Fiber Optic Testing with Go/No-Go Acceptance Criteria (2011-402)
NSRP Fiber-Optics Manufacturing and Installation (2012-469)
NSRP Fiber Optic Testing Enhancement for Cost Reduction (2016-416)

Multiple Optical Signals in a Fiber

Fiber, space, polarization, mode, amplitude, phase, frequency, wavelength, are possible domains for multiplexing signals. Wavelength is used widely.

Wavelength Division Multiplexing (WDM) combines many optical signals in a single fiber.



NSRP Paradigm for Optical Networks in Ships:
Flexible Communications Infrastructure (2016-426)
NSRP Cost Model-Based Network Design and
Testbed Performance Analysis (2018-427)

Sensing

Several device types provide sensing functions using optical fiber, and can be used for monitoring a variety of measurands.

- ❑ Extrinsic sensors
- ❑ Fiber Bragg Gratings
- ❑ Long Period Gratings
- ❑ Rayleigh scattering
- ❑ Brillouin scattering
- ❑ Raman scattering

Distributed Temperature Sensing for Inspection of Electrical Panels on Navy Ships (2017-422)

Photonic Integration

Integration refers to combining multiple functions within the same device or package.

Photonic integration can include one of several material platforms. Getting light between these platforms, e.g. waveguide alignment, is normally difficult.

Silicon photonics is an integration platform that strives to be compatible with the CMOS manufacturing process.

Non-Electrical Topside (NETS)

Optical fiber:

- ❑ transmits data (Digital or Analog)
- ❑ delivers power (<100 Watts)
- ❑ delivers light (White or RGB)
- ❑ Includes sensing functions

Within NETS, only high power is delivered by electrical cable.

Photonic Functions

Much of shipboard photonics and fiber optics is confined to transmission of signals.

Other functions can be performed using photonics:

- ❑ Image processing
- ❑ Signal processing
- ❑ Encryption
- ❑ Optical computing

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