

Use of RF Photonics in Next Generation Military Antenna Systems

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Next Generation RF Photonics

Starting Assumption:

Affordable, broadband, low noise figure, high dynamic range point-to-point microwave photonic link building blocks are available.

- These microwave fiber optic links offer:
 - Range, bandwidth and RF performance
 - Phase and amplitude stability
 - EMI immunity
 - Small size and lightweight
 - Installation flexibility

Improved microwave link technology enables enhanced wideband RF signal processing capabilities to be competitively implemented in optical domain

RF Photonic Links for Antenna Applications

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Microwave Fiber Optic System Capabilities

- RF Antenna Remoting and Signal Routing
- Local Oscillator Signal Distribution
- SCM/WDM Information Networks
- RF Signal Generation and Frequency Conversion
- RF Delay Lines, Filters, and Signal Processors
- True-Time-Delay (TTD) Beamforming



Next generation
capabilities

Military RF System Insertion Targets

Communications, Radar, Navigation,
& Electronic Warfare Systems



Emerging Thrusts

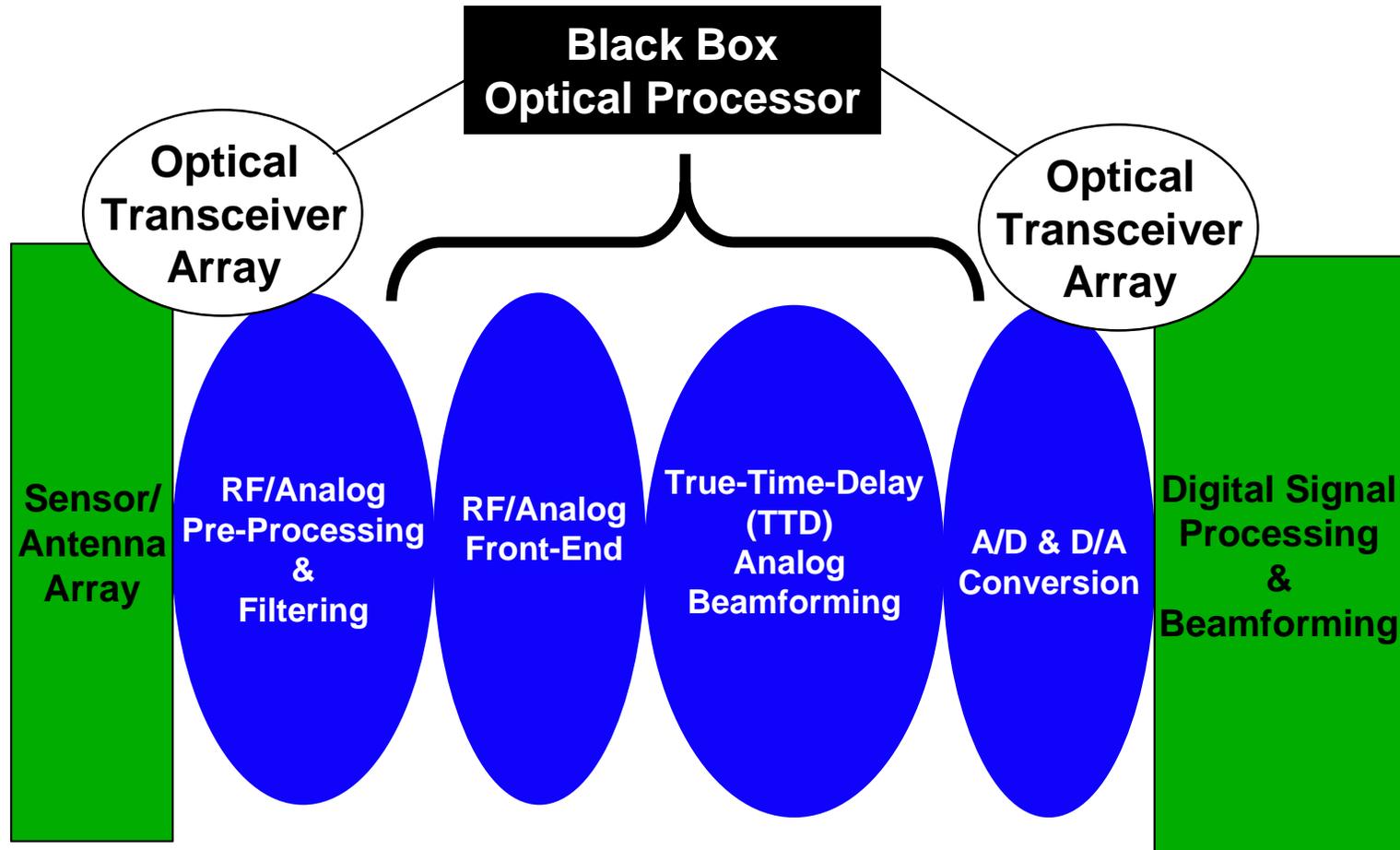
Aperture Integration &
Joint Cooperative
Engagement
Capability
JOINT VISION 2020

Related Commercial Markets & Technologies

- Telecommunications & Broadband Access
 - Voice, Video & Data Services
 - DWDM, CATV, HFC, FTTC, FTTH, LAN, MAN, WAN, etc.
- Millimeter-wave Radio (HFR)
 - 38 GHz, 60 GHz Radio over Fiber

Next Generation RF Photonics for Military Antenna Systems

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- Significant Technology Insertion Opportunities Exist!
- RF Performance and Cost is Critical

RF Technology in Next Generation Military Antenna Systems



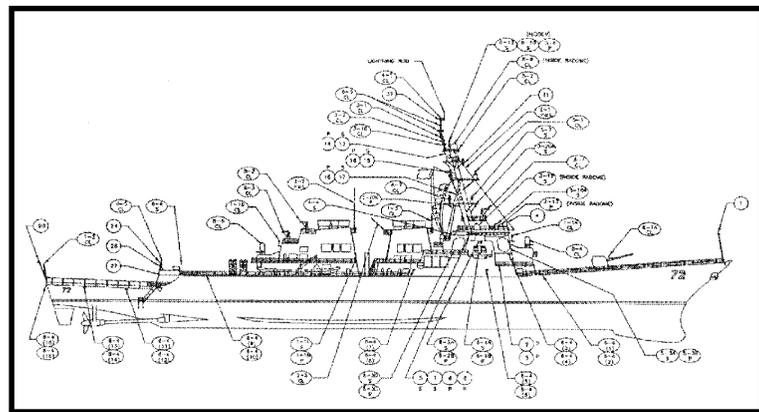
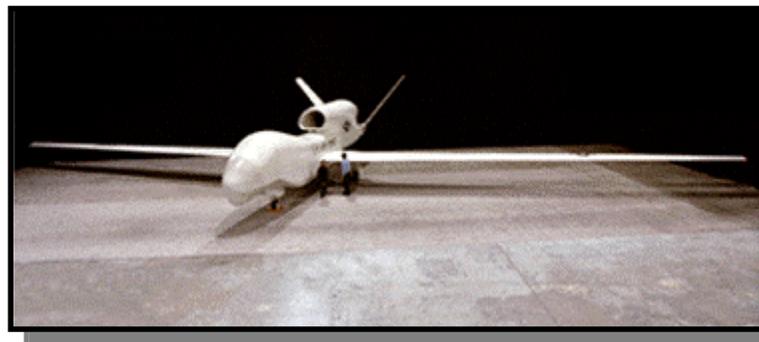
ARCH

Advanced Rf teCHology

*The Bridge between the
Digital Revolution
and the
Information Revolution*

ARCH Technical Challenge

- **New technologies**
 - UAV relays
 - Software radios
 - High capacity point-to-point links
 - Shared apertures / Active arrays
- **Antenna proliferation**
- **Growing spectrum demands**
 - Communications
 - Weapons
 - IFF, navigation
 - Surveillance & reconnaissance



**Total communication performance
is limited by RF performance**

Antenna and RF Front-End Performance Limitations for Multi-Mission Platforms



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Broadband Highly Directive RF Antennas

- Multi-band, multi-beam phased-array antenna operation
- True-time-delay (TTD) beamforming

Antenna RF Front Ends

- High-speed / high-power / high-linearity / efficient T/R modules
- High performance RF mixers

Electronic Packaging

- High-speed / high-power / high-isolation MCMs

Cosite Interference

- High isolation RF signal distribution and filtering
- Adaptive filtering & Interference cancellation

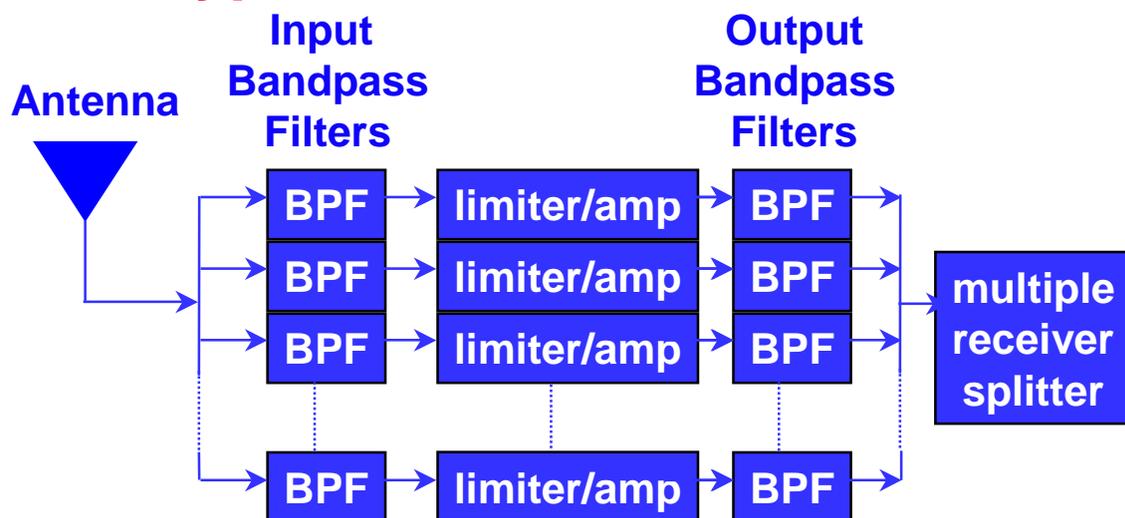
RF Photonics can help to overcome some of these antenna system limitations!

RF/Analog Pre-Processing & Filtering (Example 1)

Broadband Antenna Filtering Technology

Typical Electronic Receiver

**LNAs & HPAs
Severely Limit
RF Performance in
Multi-Octave
Multifunction Antennas
(AMRFS: 1-5 GHz; 5-20 GHz)**



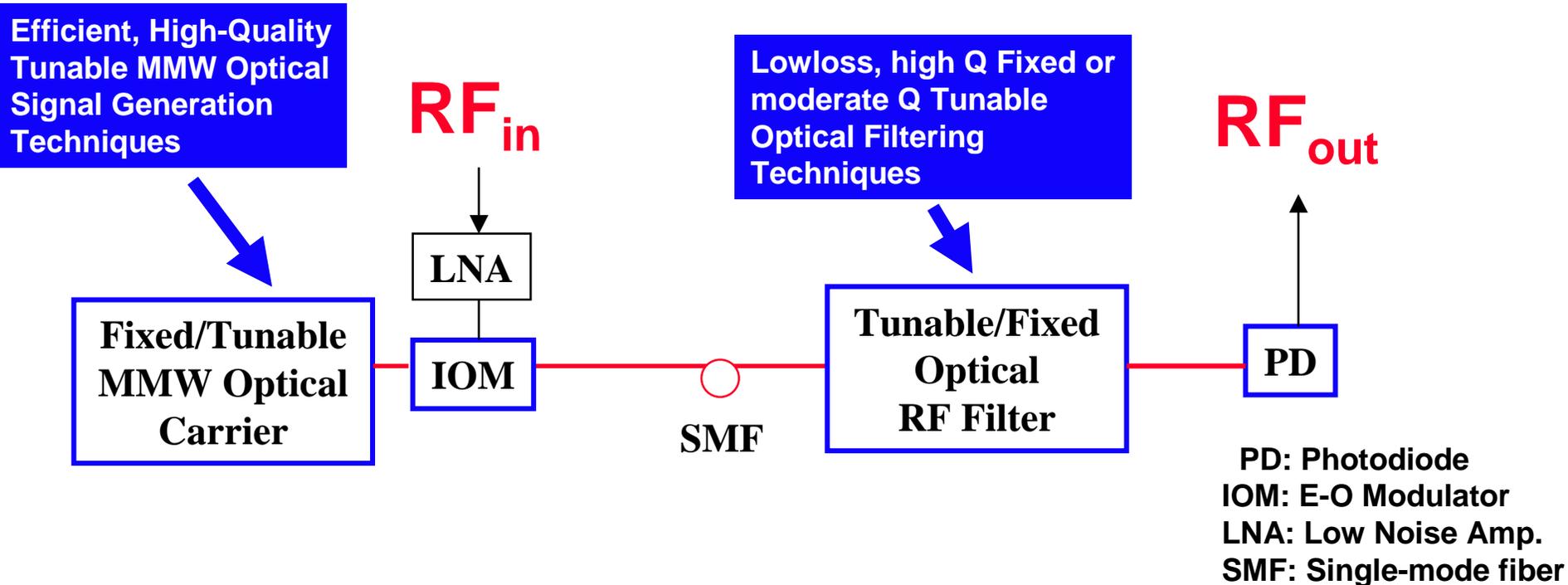
RF Photonic Insertion Opportunities

- Channelizers/Filter Banks (Fiber Delay Line, FBG & Mode-Locked Laser Approaches)
- Broadband Tunable RF Filters (High-Q Micro-Optical Resonators, DWDM Filters)
- Reconfigurable Antennas & Tunable Frequency Selective Surfaces (MEMs)
- Broadband Microwave Switches & Switch Arrays (Polymer, LiNbO₃, III-V,)

RF/Analog Front-End (Example 2)

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Frequency Converting Photonic Links (All Optical Superheterodyne Receivers)



- Eliminates need for electronic mixer (reduced front-end complexity)
- Incorporates pre-selector filtering in optical domain
- Compatible with **commercial millimeter-wave fiber-radio systems & DWDM filtering technologies**

Summary

- The “Digital Receiver” concept is an elegant antenna signal processing solution, however conventional ADC technology will have difficult time meeting emerging military front-end antenna system requirements.
- Microwave photonic links and RF Photonics will make their way into military antenna systems.
- As photonic link performance continues to improve, RF Photonics insertion into antenna systems will expand in areas including:
 - RF pre-processing & filtering
 - RF front-end technology
 - A/D conversion
 - TTD beamforming