

MTO Electronics & Photonics

“The RF Story”



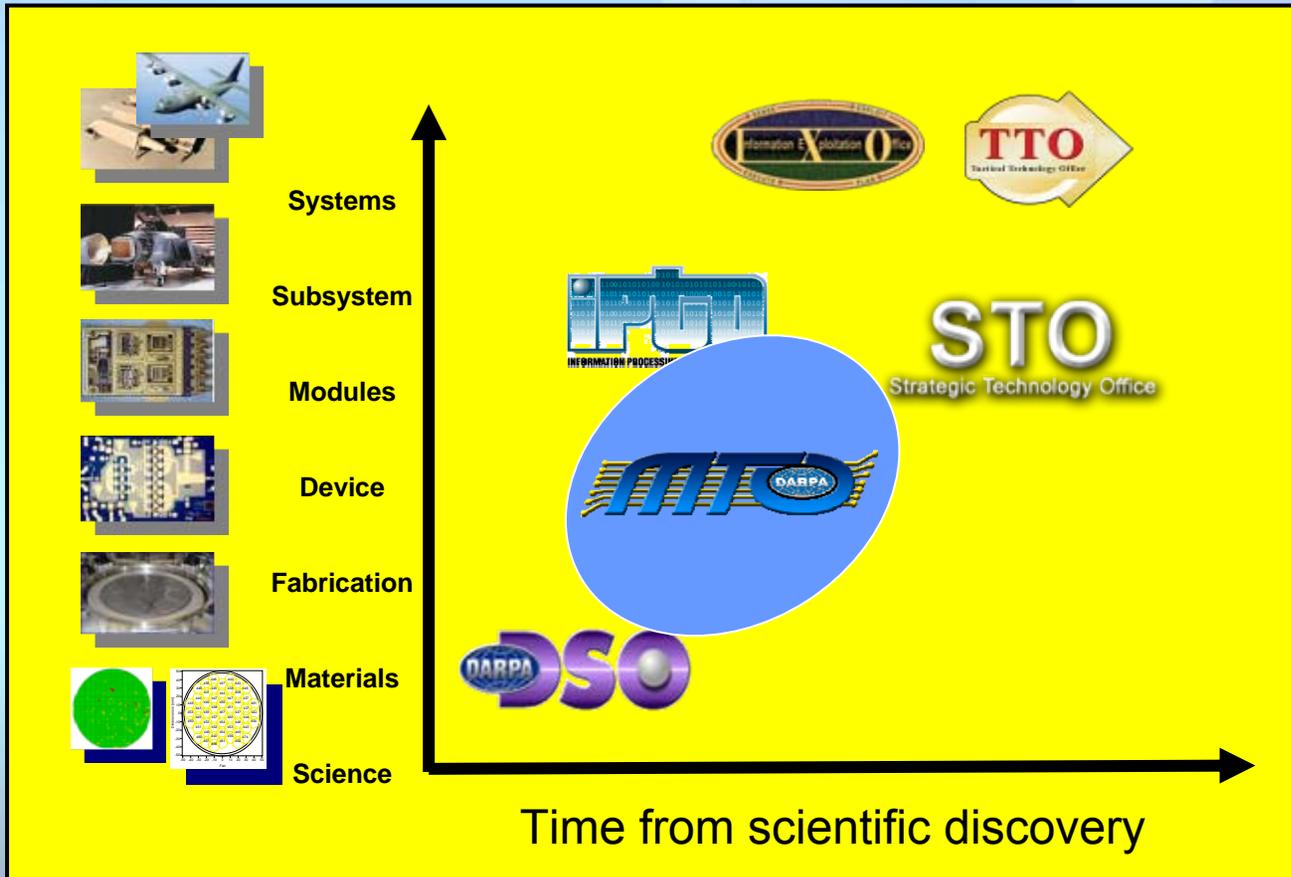
Dr. Steve Pappert
Program Manager
DARPA / MTO

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Where Does MTO Fit Into The DARPA Vision?



I'm Going To Give You The 10 Minute MTO RF Systems Big Picture Story



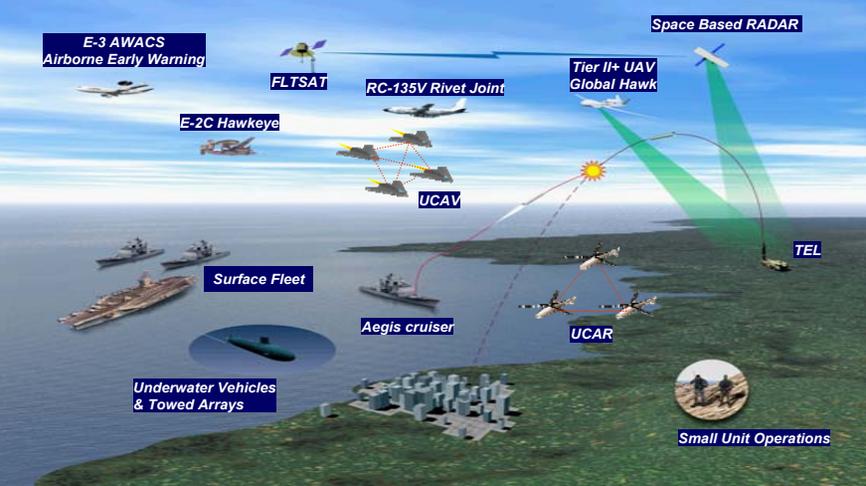
“The Need For Better Widgets”

C4ISR Mission Systems



21st Century RF Technologies Are Changing The Way We Engage Our Adversaries

Networked Manned and Unmanned Systems



See Anything... From Anywhere... At Anytime...

PERSISTANT, STANDOFF SURVEILLANCE

AND

Provide Real-Time Global Information Distribution

SENSOR TO SHOOTER INFORMATION GRID

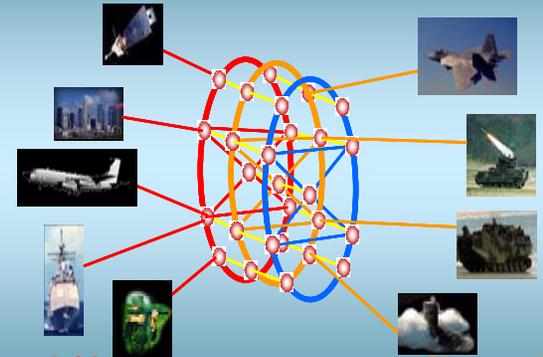
Expanding ISR Demands

SIGINT IMINT MASINT

Multi-INT



Expanding COMMS Demands



Sensor Grid Information Grid Shooter Grid

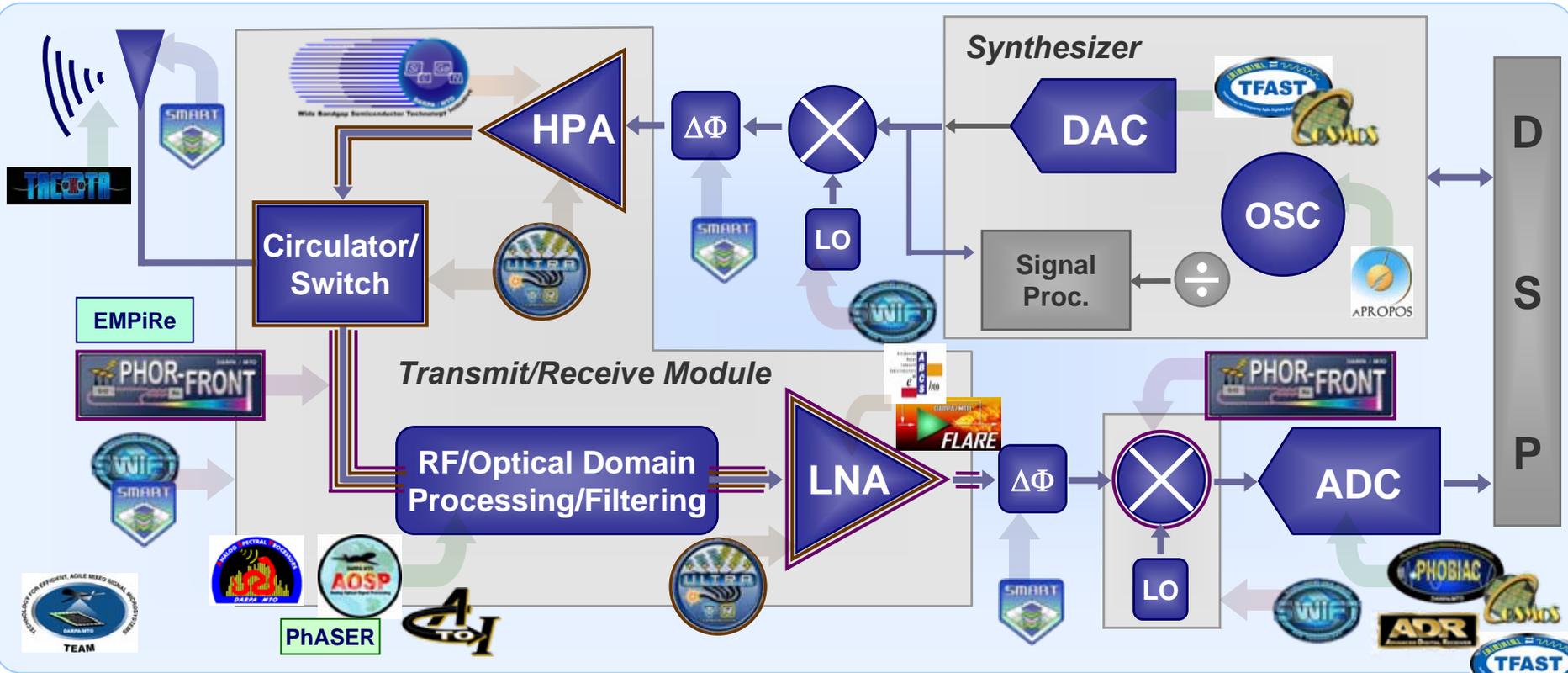
Need for RF Systems With Increased Sensitivity, Bandwidth & Dynamic Range



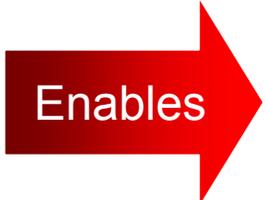
RF Front-End Technology Trajectory On Target To Satisfy Near-Term Military RF Systems Needs



DARPA's Current Programs ↔ Tomorrow RF Front-End Solutions



- Many DARPA/MTO RF Programs across the spectrum addressing:
 - Optimized Materials for RF Performance
 - Survivability
 - Robustness



Network Centric Warfare





Sampling of Current MTO Programs T/R Programs Relevant to RF Systems

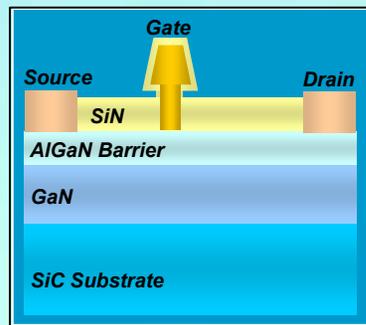


Wide BandGap Semiconductors for RF Applications (WBGs-RF)

Program Goal:

Reliable, high performance devices and MMICs with

- higher power
- superior thermal performance
- higher efficiency

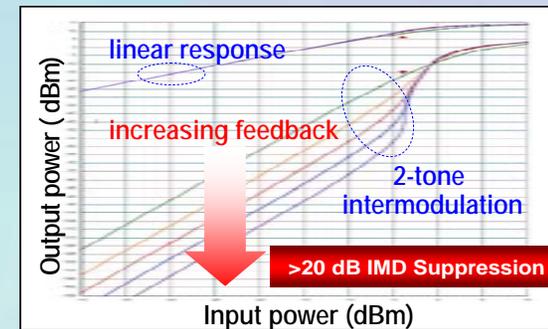


Feedback Linearized Amplifiers for RF Electronics (FLARE)

Program Goal:

Ultra-high linearity microwave low noise amplifier (LNA) – a microwave op-amp

- +60 dBm OIP3
- 1 W PDC
- Trade transistor speed for linearity

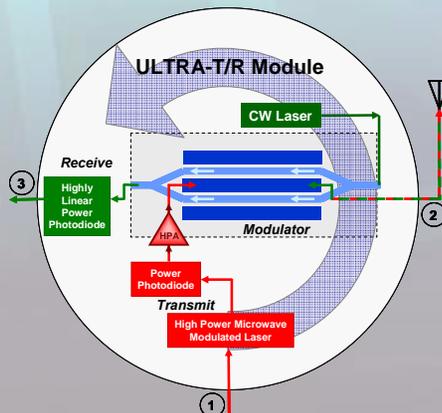


ULTRA-Wideband Multifunction Photonic T/R Module (ULTRA-T/R)

Program Goal:

Distributed photonic RF Transmit/Receive (T/R) module for Simultaneous Transmit And Receive (STAR) single- and multi-element RF apertures

- >75 dB T/R isolation over octave bandwidth

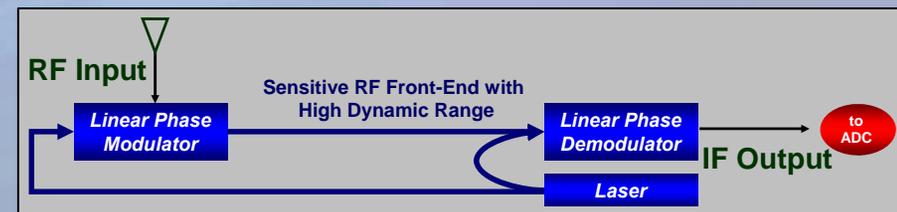


Linear PHOtonic RF FRONT-End Technology (PHOR-FRONT)

Program Goal:

Ultra-high linearity photonic RF front-end

- ~150 dB-Hz^{2/3} SFDR





Sampling of Current MTO Programs

Mixed Signal Programs Relevant to RF Systems

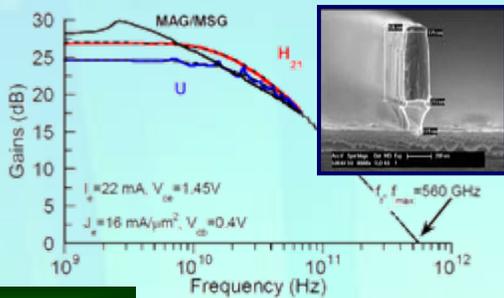


Technology for Frequency Agile Digitally Synthesized Transmitters (TFAST)

Program Goal:

Digital synthesis of RF signals with

- high dynamic range
- low phase noise
- low DC power
- wide bandwidth



World's 1st transistor with f_t & f_{max} simultaneously > 500GHz



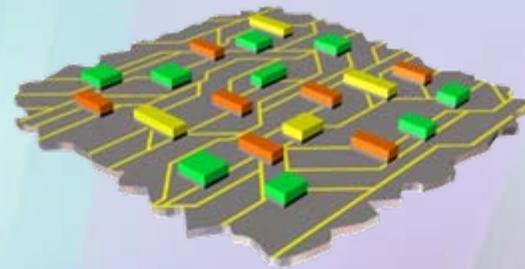
COmpound Semiconductors Materials On Silicon (COSMOS)

Program Goal:

Heterogeneous integration at the transistor scale

- Enable materials selection within circuits

- 16 SNR bits
- 500MHz BW
- SFDR \geq 98 dBc
- Power \leq 4W

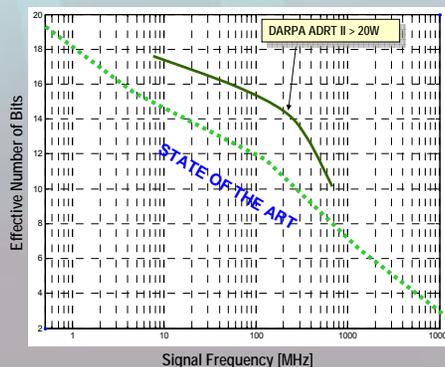


Advanced Digital Receiver Technology (ADRT)

Program Goal:

Advance the state of analog-to-digital converters and other receiver technology

- 16 effective bits
- 100 MHz instantaneous bandwidth
- >100 dB spurious free dynamic range (SFDR)

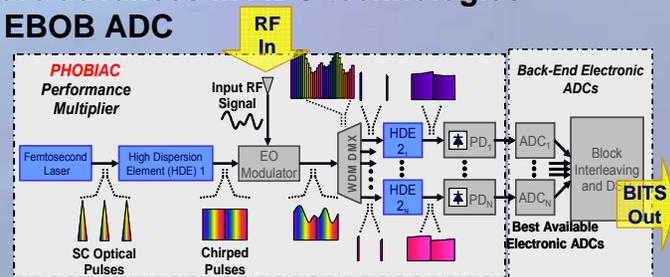


PHOtonic Bandwidth Compression for Instantaneous Wideband A/D Conversion (PHOBIAC)

Program Goal:

Power-efficient ADC Performance Multiplier that leverages any current/future advances in ADC technologies

- 10 GHz / 10 EBOB ADC
- < 40 Watts





Extreme Sensor Resolution

How Do We Get There?



Need for:

- Increased Sensor Bandwidth
- Increased Time, Frequency & Navigation Precision
- Increased Intra- & Inter-Platform Information Exchange

DARPA/MTO's Role

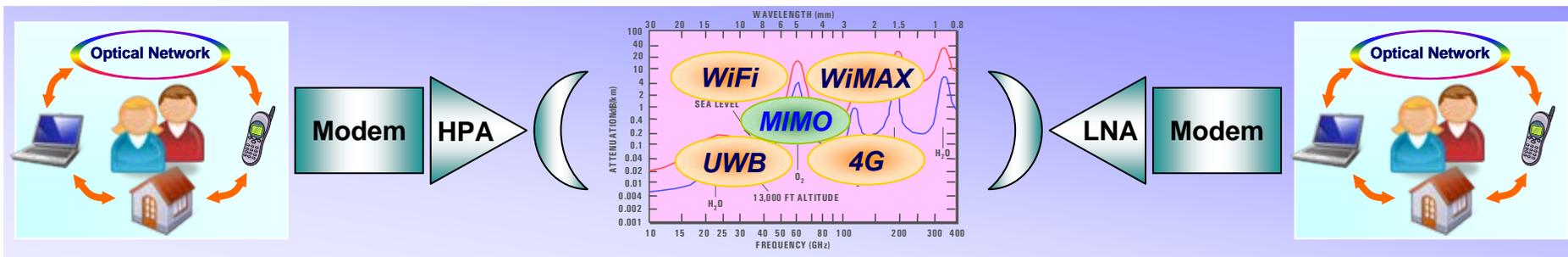
Radical Improvement In:

- RF Amplifier & Mixer Technologies
- Oscillators (Optical & RF)
- Agile Filtering Technologies
- ADC/DAC Technologies
- Signal Processing/Algorithm Technologies
- Inertial Navigation Technologies

**Required Technologies Span All MTO
Program Managers Interests In Some Form**

The Last-mile Solution

Novel technologies maximizing the utilization of time, frequency, and spatial domains



Technical Challenges

- ADC/DAC
- Forward Error Correction
- Distortion Mitigation
- Smart Antenna
- Bandwidth Efficiency
- LNA/HPA
- Spectrum Availability

Bandwidth & Spectral Efficiency → Millions of Available Multi-Mbps Channels



Some Key Technology Enablers



Electronics

- Higher-speed, low power DSP
- Higher-speed mixed signal circuits
- Sub-MMW electronics
- Linear amplifiers & mixers
- Narrow-band fast-tunable RF filters
- Low phase noise oscillators
- Wideband Electronically Steered Arrays
- Real-time processing & algorithms

Photonics

- High performance RF transmission links
- λ -stable low phase noise optical oscillators
- Sub-MMW photonics
- Optical Phased-Locked-Loops (OPLLs)
- Fast-tunable optical filters
- Optical phased arrays
- Optical signal processing
- Opto-Electronic Integration

As we are successful in MTO, revolutionary increases in RF system capabilities will be available for our warfighters and commanders, providing coordinated situational awareness for tactical and strategic superiority

**See Anything...
From Anywhere...
At Anytime...**

Please Help Us Make This Happen!

- Our Continued Battlefield Dominance Depends On It -