Reconfigurable Imaging (ReImagine)

Dr. Jay Lewis

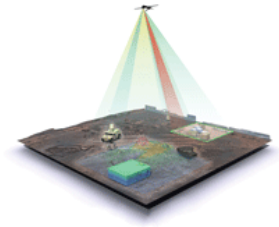
DARPA/MTO

ReImagine Proposers Day

September 30, 2016

Agenda

ReImagine Proposers Day



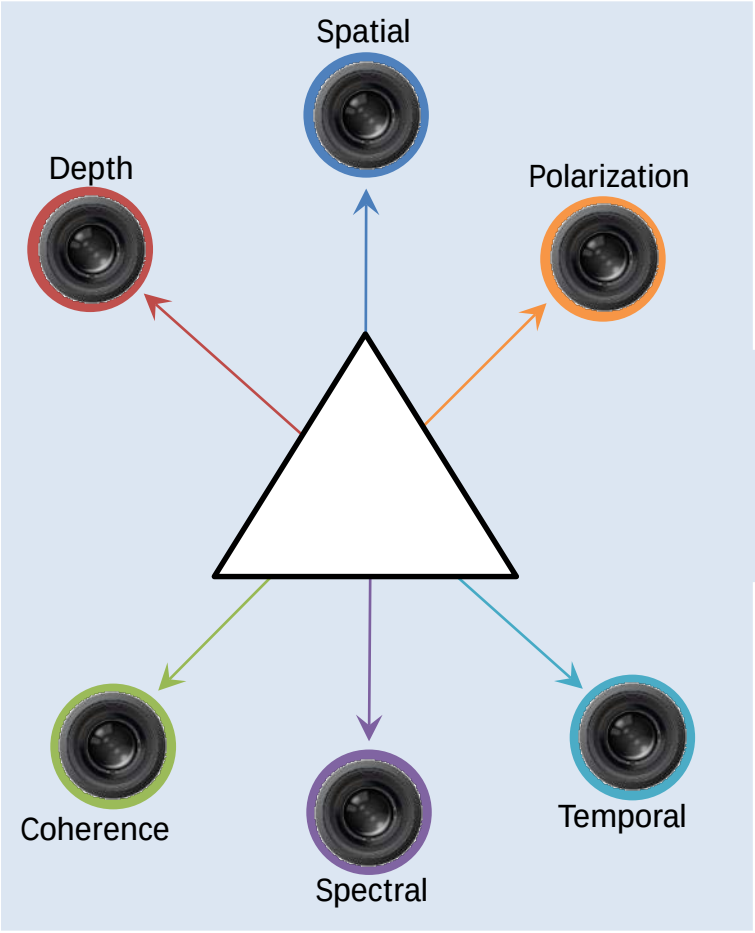
Arlington, VA
September 30, 2016

Agenda

Time		Event/Topic	Speaker	Location
8:00AM	9:00AM	*Registration Check-in*	-	*Lobby Hallway*
9:00AM	9:10AM	**Welcome / Ground Rules**		
9:10AM	9:45AM	**ReImagine Overview & Structure**	**Jay Lewis** DARPA/MTO	Ballroom
9:45AM	10:00AM	**Question and Answer Session**		
10:00AM	10:30AM	**Reconfigurable Integrated Circuits for ReImagine**	**Jon Frechette** MIT – Lincoln Laboratory	Ballroom
10:30AM	10:45AM	**DARPA Security**	**Jaime Nelson** DARPA/MTO Program Security Representative	Ballroom
10:45AM	11:15AM	**Contracting with DARPA**	**Mark Jones** DARPA Contracts Management Office	Ballroom
11:15AM	11:30AM	**Question & Answer Session**	-	Ballroom
11:30AM		*Break for Lunch*	-	-
12:00PM	4:30PM	**One-on-One Breakout Sessions**	-	Fairfax Room
4:30PM		*Adjourn*		

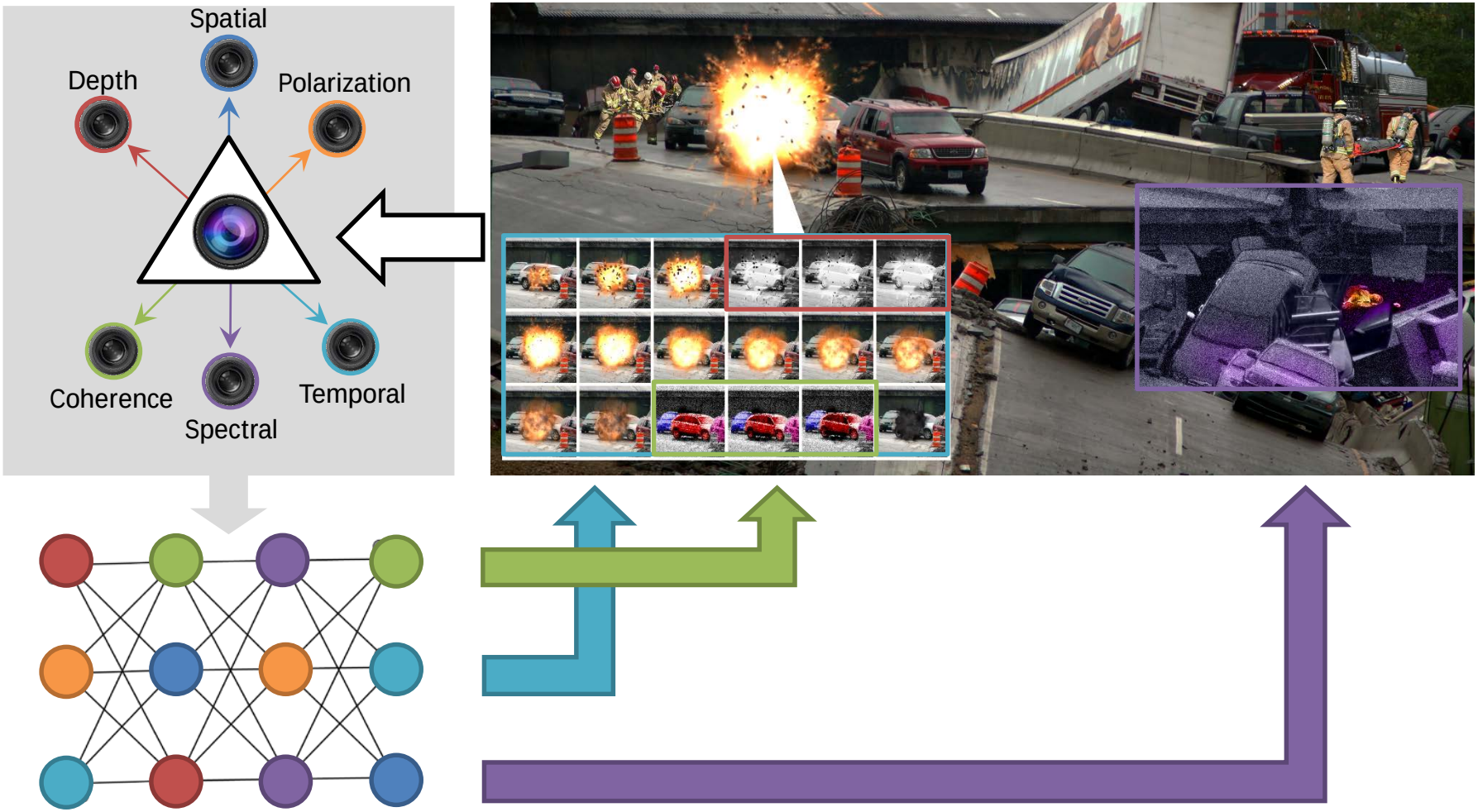
The objective of ReImagine is to develop a **software-reconfigurable** imaging architecture to enable **multi-mission functionality** in a single camera

ReImagine Concept



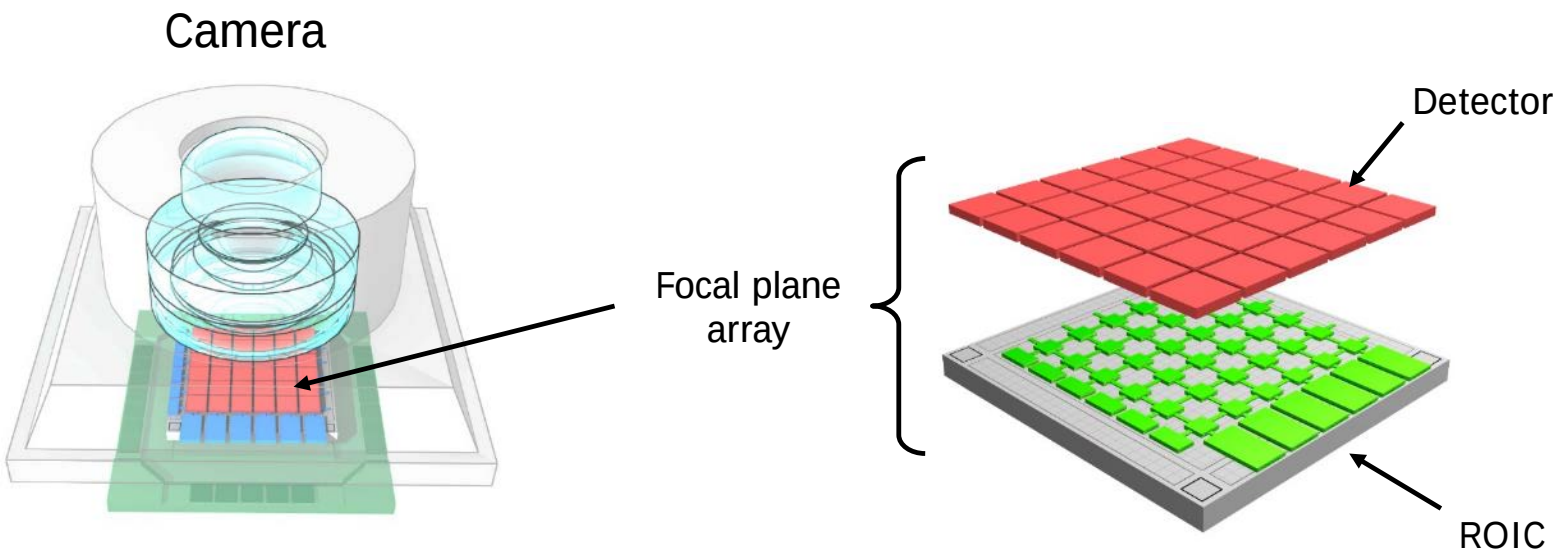
How can access to multiple dimensions of optical information in a single camera give more meaningful information for DoD and commercial applications?

ReImagine Concept



How can access to multiple dimensions of optical information in a single camera give more meaningful information for DoD and commercial applications?

Readout Integrated Circuits (ROICs)



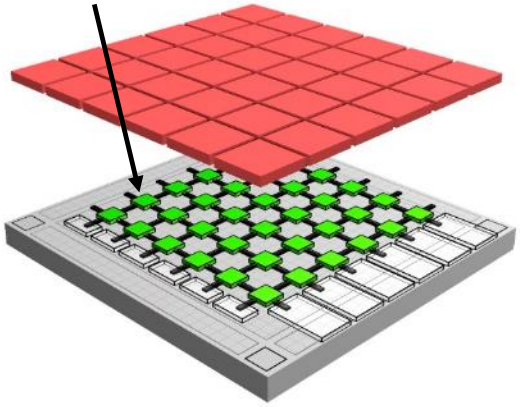
A ROIC has 3 fundamental functions:

1. Sample data from the detector (per pixel)
2. Transfer data from the array to the periphery
3. Transfer data off the chip

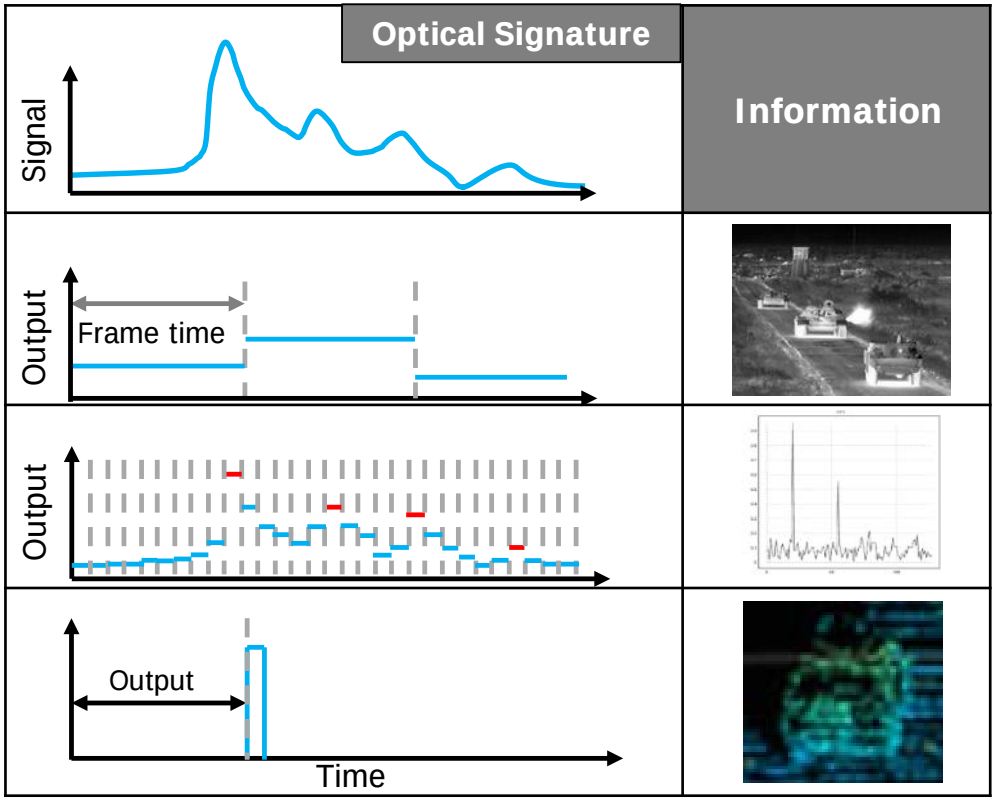
Adaptable Pixel Circuits

ROICs Today	ReImagine
Optimized for type of detector, application, conditions	**Adapt** for any detector, sample at variable spatial or temporal resolution, framing or asynchronous, or active time of flight

Pixel level front-end circuit



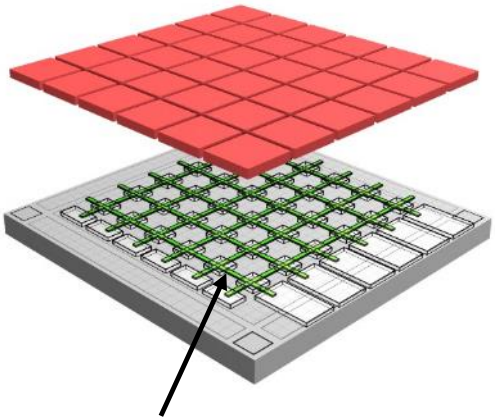
Every pixel in the detector array is connected to the front-end circuit of a ROIC that is optimized to sample the detector signal



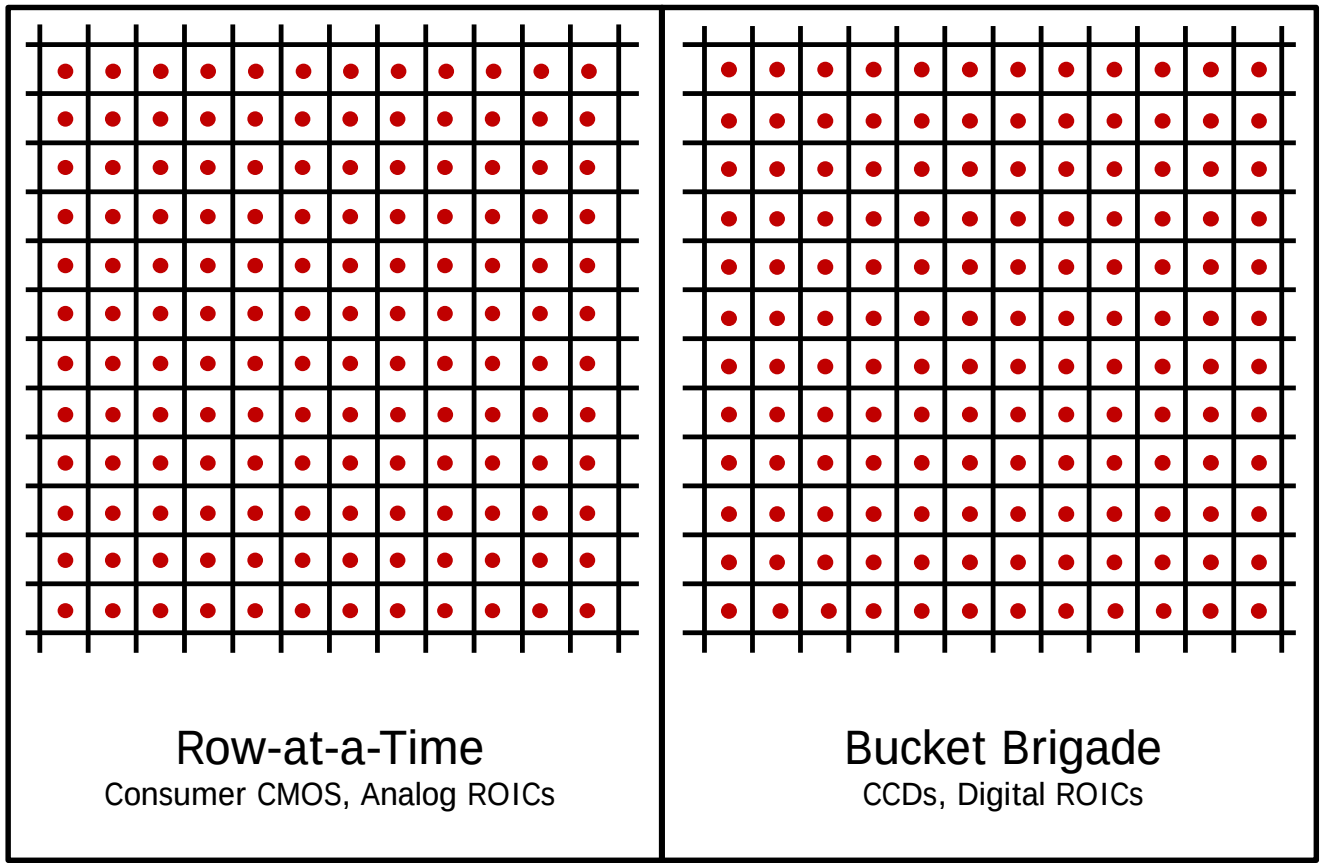
Images from: www.sofradir-ec.com/
www.pcworld.com

Versatile Data Transport

ROICs Today	ReImagine
Global process, inflexible	**Random access** to data, versatile region-of-interest operation

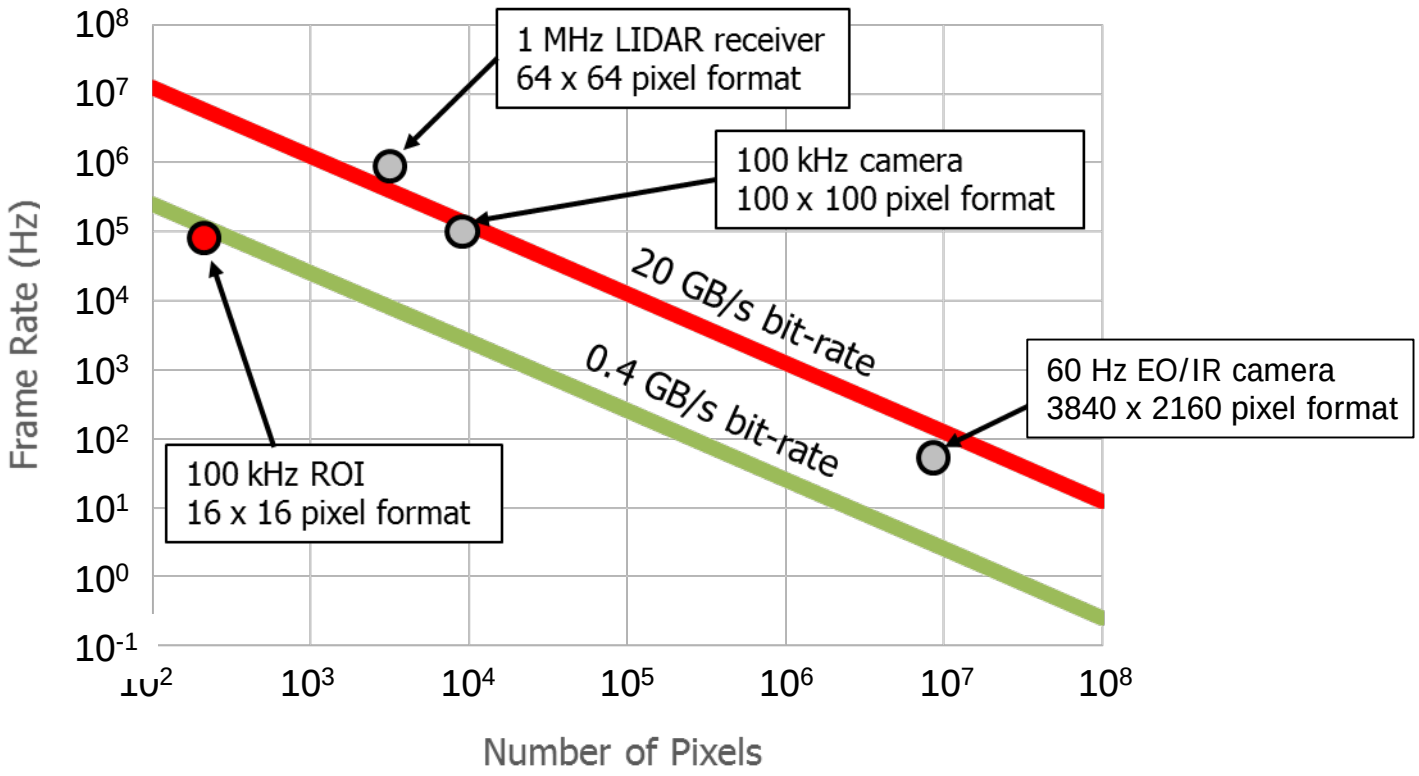


Row-column interconnects

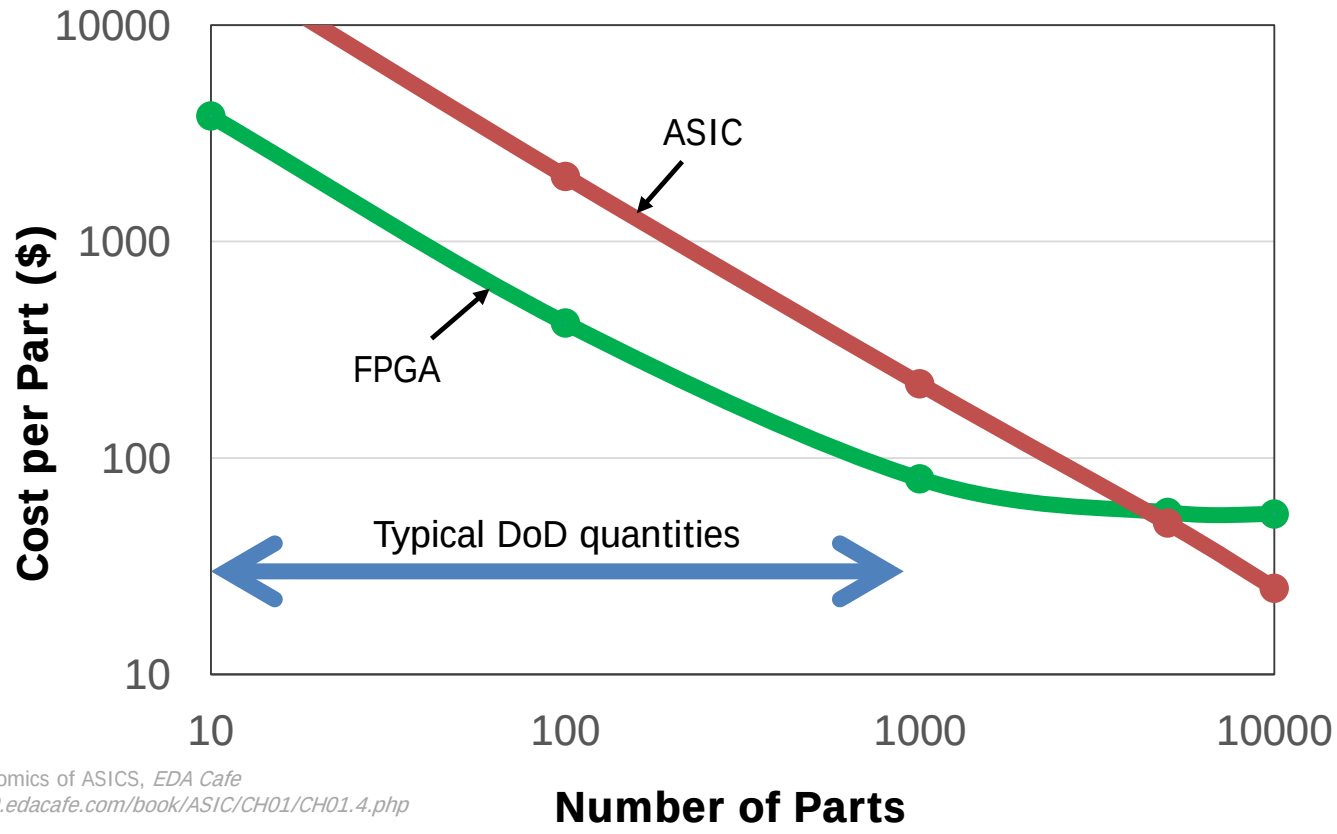


Reconfigurability Circumvents the Limit on Bandwidth

ROICs Today	ReImagine
Data bandwidth imposes resolution vs. framerate tradeoff	Enables **complex measurements** with high resolution context imagery



Programmability Enables Complexity at Low Volume



Source: Economics of ASICS, *EDA Cafe*
http://www10.edacafe.com/book/ASIC/CH01/CH01.4.php

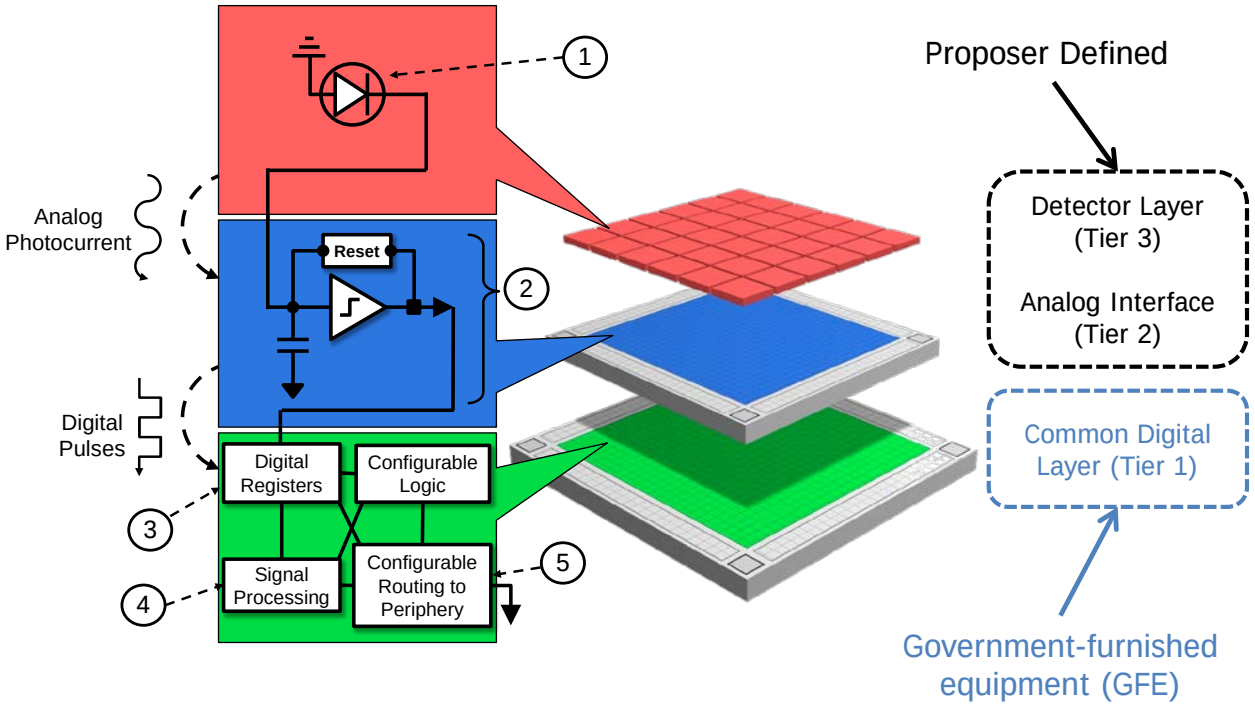
ASIC – Application specific integrated circuit

FPGA– Field-programmable gate array

FPGA model offers:

- Fastest route from concept to demonstration
- Cutting-edge capabilities in low-volume production

ReImagine Concept Architecture



Fine print:

Tier 3 and Tier 2 nomenclature consistent with this figure is used for clarity. Proposals that design these layers differently, or incorporate additional layers or features are still of interest.

Tier 1 will be provided as GFE as described in the BAA. Proposals to develop Tier 1 are not of interest. Performer input will be used to guide Tier 1 design.

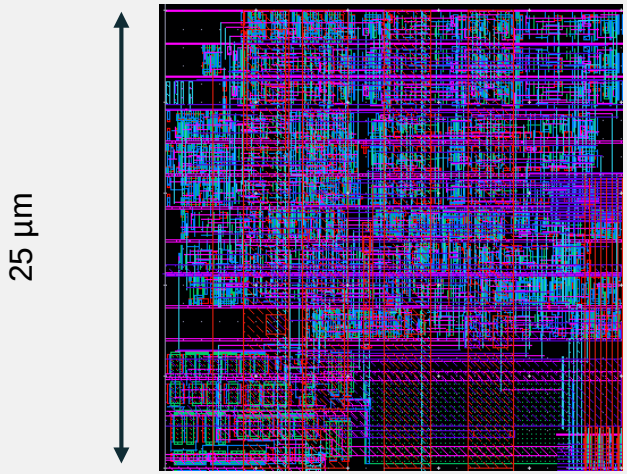
ReImagine architecture enables:

- Advanced node for the digital layer
- Optimum node for the analog interface
- Customization for many detector types
- Innovation in the analog interface

CMOS Scaling

Today

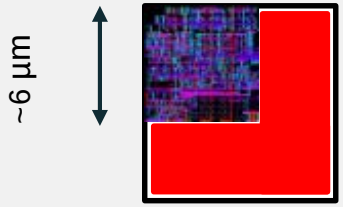
65nm CMOS



625 µm² pixel

ReImagine

14nm CMOS

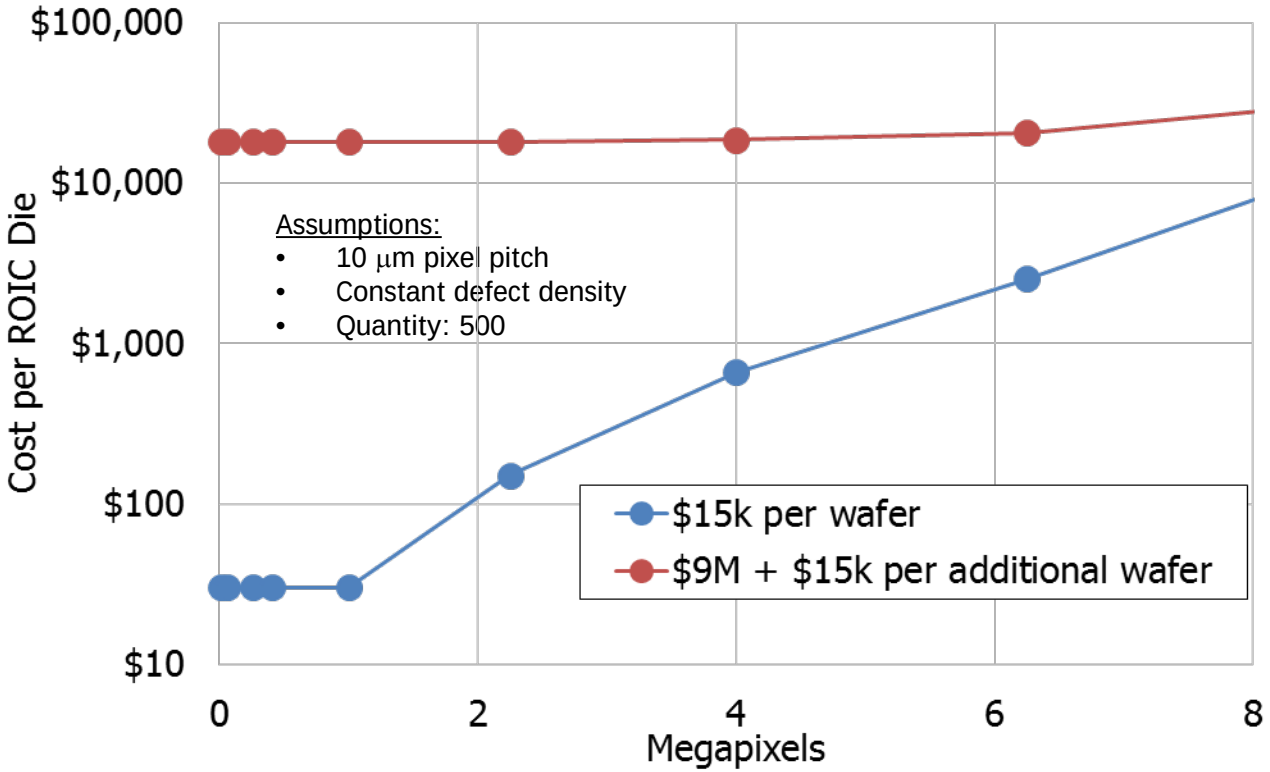


36 µm² pixel plus overhead for programmable logic

Scaling transistor gate length provides inverse square improvement in pixel pitch

Cost

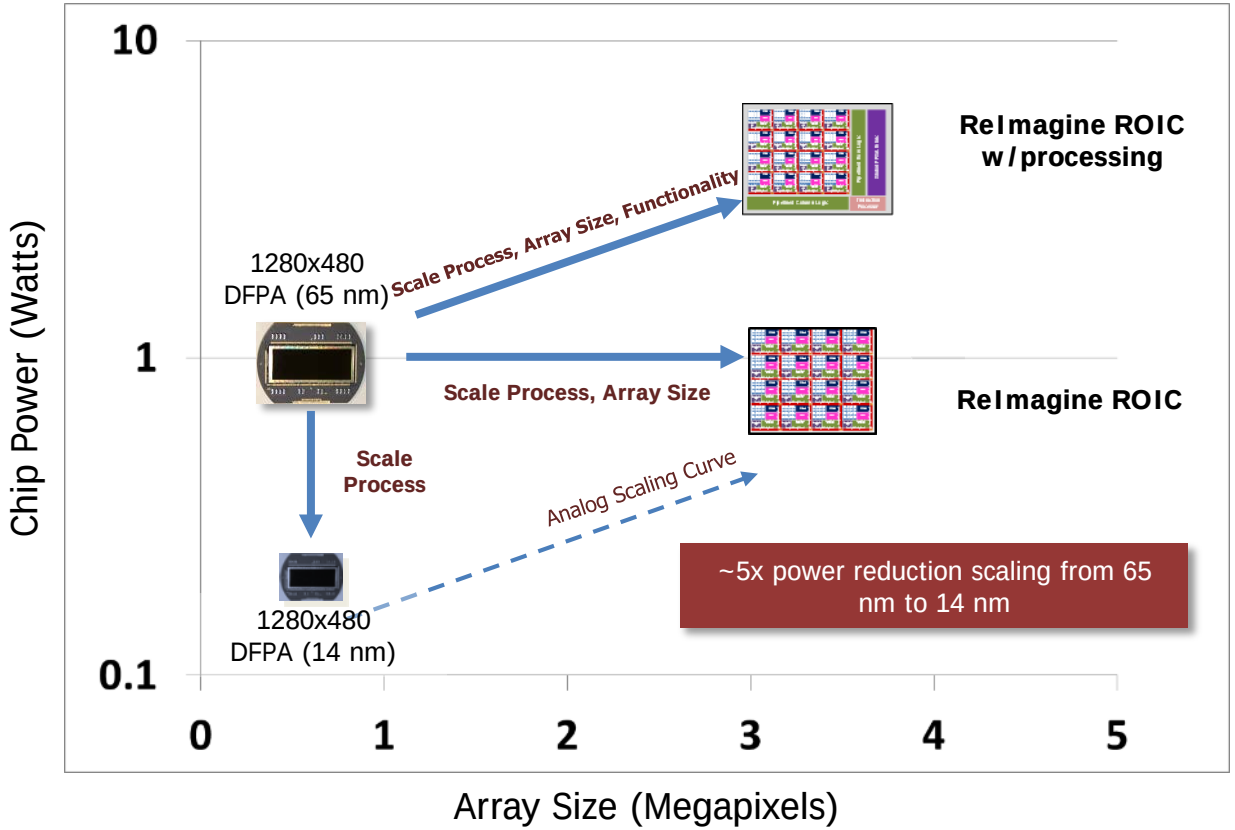
- Non-Recurring Engineering (NRE) is prohibitive only for low volume designs
- Re-use cost is negligible
  - Re-use also lowers cost of ownership



Enabling re-use also achieves cost viability

Leveraging Power Efficiency of 14 nm CMOS

Scaling to 14 nm provides power savings that can be leveraged to increase array size and allow on-chip processing



**Power and array sizes are notional. Refer to the BAA for guidance on array sizes for proposal planning

- 10 – 20x multiplier in system power for additional power consumed at typical cryogenic temperatures
- ReImagine performers should develop a framework for optimizing system power consumption

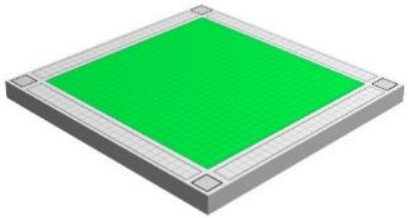
ReImagine Technical Areas

- **Technical Area 1:** Single or multi-color passive imager architecture and algorithms
  → If no illumination source is needed for your application, it is a TA1 proposal
- **Technical Area 2:** Hybrid active/passive imager architecture and algorithms
  → If an illumination source is needed for your application, it is a TA2 proposal
- **Technical Area 3:** Innovative concepts for imaging systems with internal feedback

ReImagine Program Structure: TA 1&2

MIT-LL
Hardware and Software

- Digital layer design
- Software development
- Design documentation

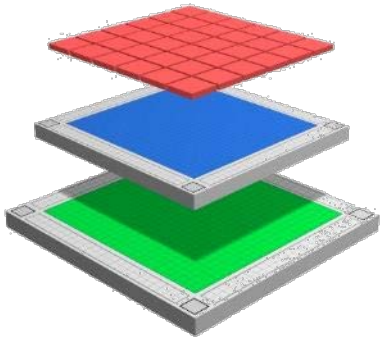


- Digital layer (Tier 1)
- Specification for Tier 1
- Verilog models for simulation of Tier 1
- Benchmark models
- FPGA CAD design flow
- Analog interface requirements
- Development kit

- Digital layer (Tier 1) requirements

TA 1&2 - Performers
Applications

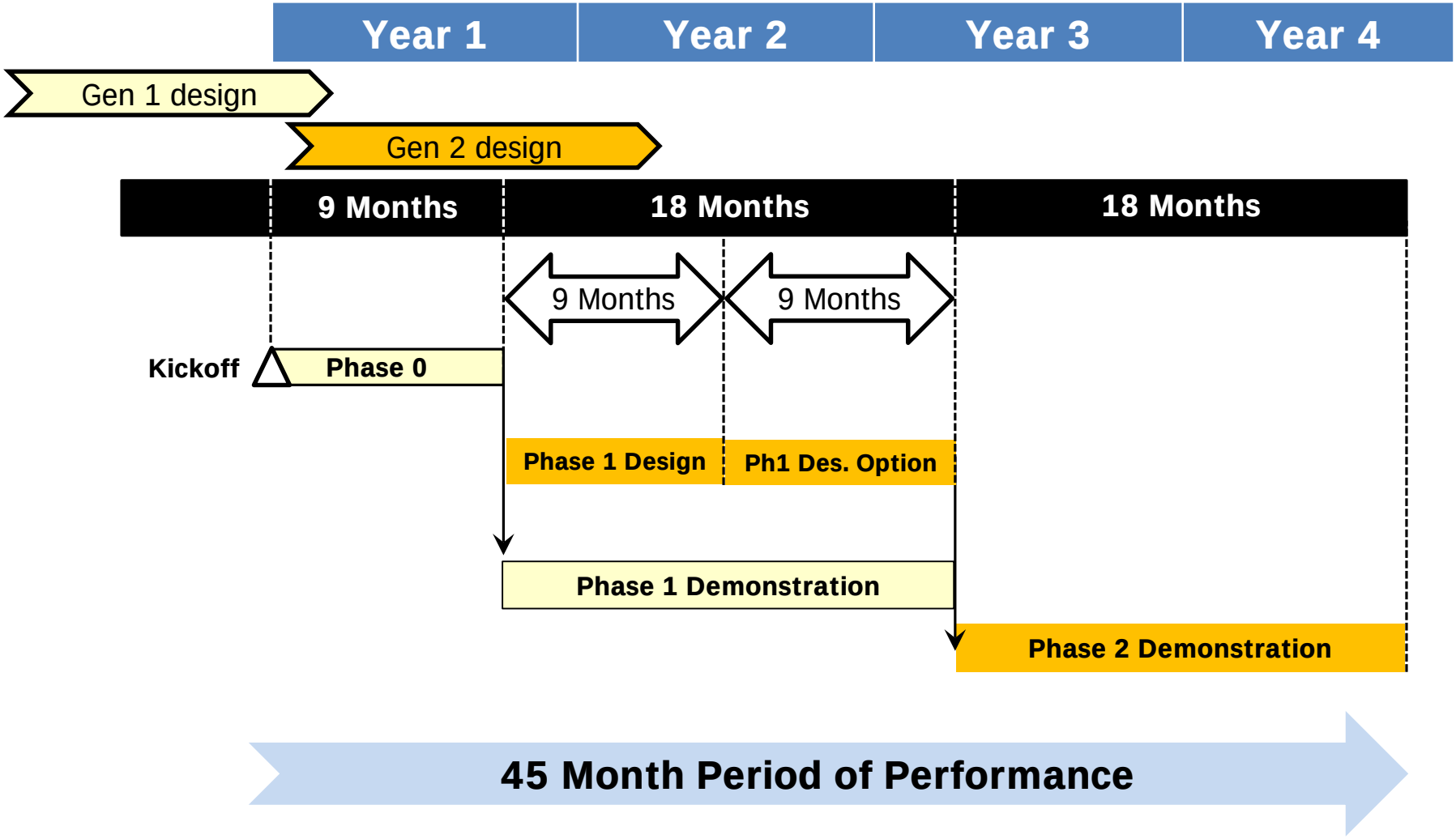
- Applications, algorithms, requirements
- Analog layer design, fabrication
- 3-D integration
- Phase 1 and 2 demonstrations



Applications of Multifunctional Imaging

Images from: (clockwise from top left)
www.cnn.com
commons.wikimedia.org
www.soldiersystems.net
www.nvidia.com
commons.wikimedia.org
www.pixelteq.com
navylive.dodlive.mil
www.yellowheadunmanned.com
www.spacetoday.org

Timeline: TA 1&2



Phase 1 Description

There are two parallel parts of Phase 1:

Phase 1 Demonstration

- Performers will demonstrate multifunction imaging in hardware, using the Gen 1 digital layer
- Concepts for Phase 1 Demonstrations will be refined during Phase 0

Phase 1 Design

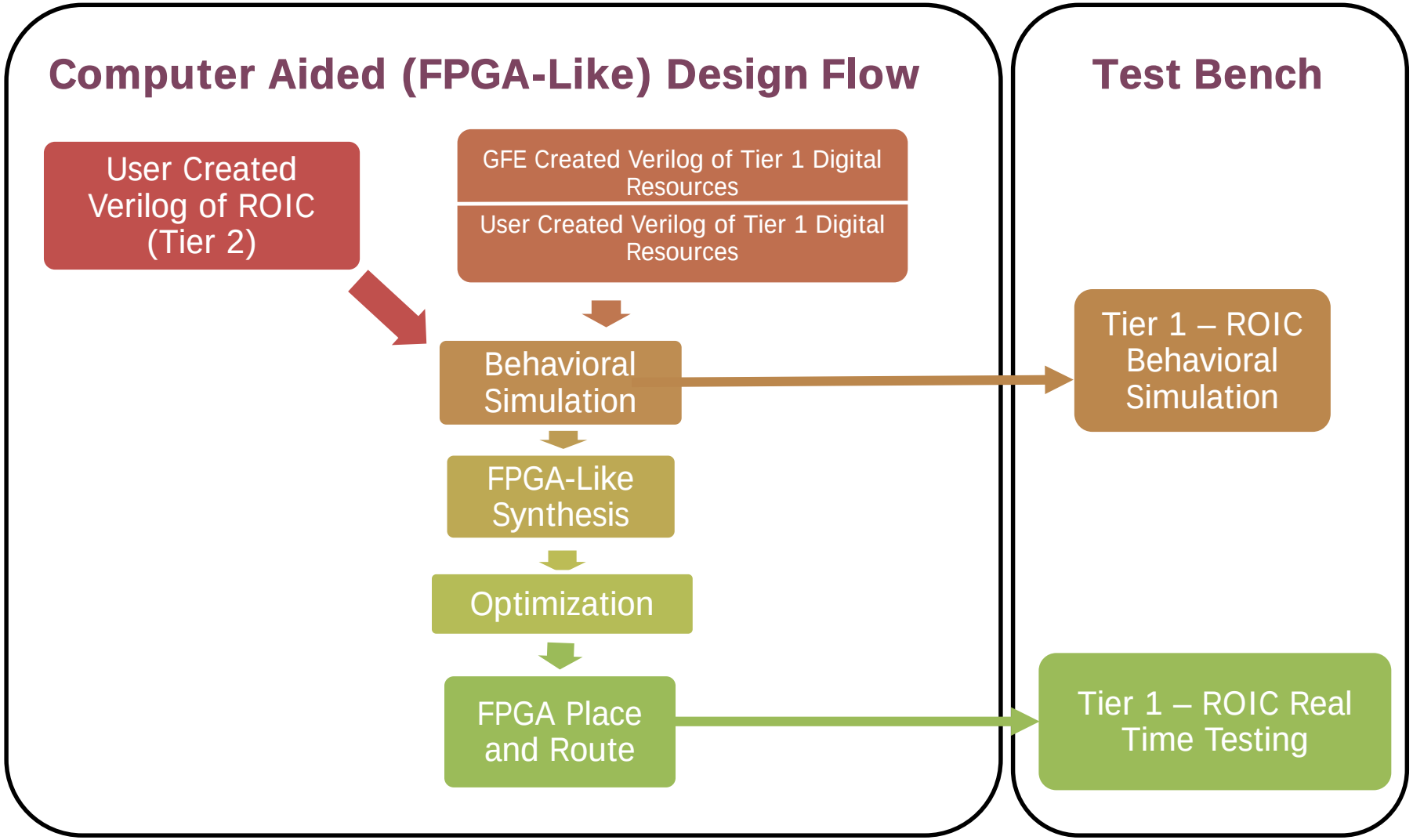
- Performers will refine algorithms and demonstration details using the Gen 2 software

**Note that other activities are embodied in Phase 1, refer to the BAA for a full description

Additional notes:

- Performers may be selected for Phase 1 Demonstration, **or** Phase 1 Design, **or** both
- If you believe that your application will **not** be supported by the Gen 1 digital layer, but **may** be supported by the Gen 2 digital layer, you may choose not to propose to the Phase 1 Demonstration tasks
- It is expected that most proposals will include Phase 1 Demonstration tasks
- **All proposals** should include Phase 2 Demonstration tasks

ReImagine Computer Aided Design Flow



Performance Objectives

Table 3.

	Phase 1	Phase 2
Spectral Band(s) (µm)	Proposer Defined	Proposer Defined
Pixel Pitch (µm)	≥ 10 µm	≥ 8 µm
Array Format	640 × 512	1280 × 1024
Imaging mode (TA1 and TA2)		
Distinct imaging modes of operation	≥ 3 (TA1) ≥ 2 (TA2)	≥ 4 (TA1) ≥ 3 (TA2)
LSB (e^-)	Proposer Defined	Proposer Defined
Front end noise (e^-)	Proposer Defined	Proposer Defined
Range mode (TA2 only)		
Front end bandwidth (GHz)	Proposer Defined	Proposer Defined
Range Precision (m)	Proposer Defined	Proposer Defined
Crosstalk (%)	Proposer Defined	Proposer Defined
Photon collection efficiency	Proposer Defined	Proposer Defined
Noise equivalent photons	Proposer Defined	Proposer Defined
Minimum time between events (µs)	Proposer Defined	Proposer Defined

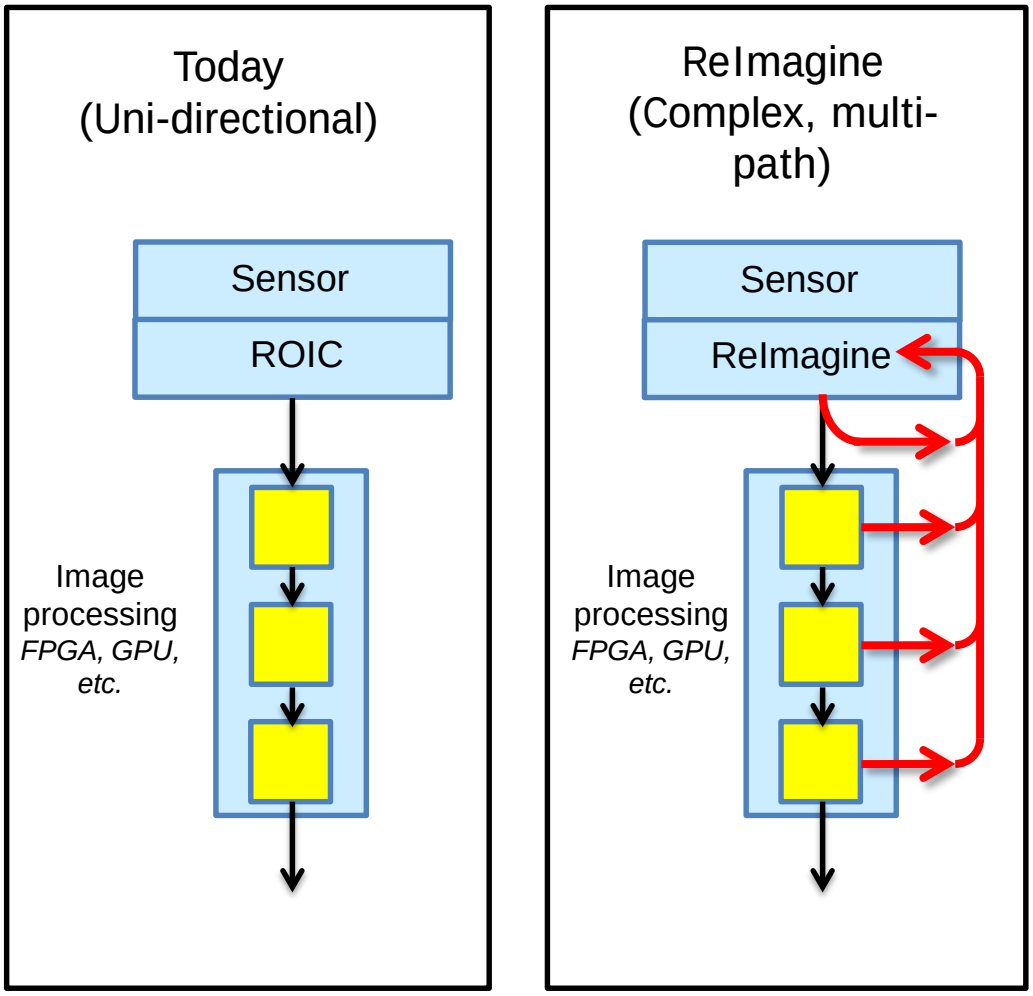
Table 4.

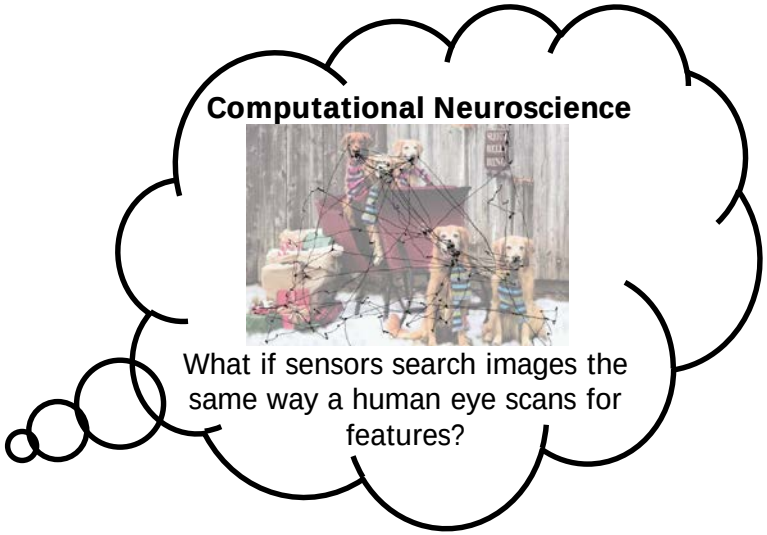
Distinct modes of operation	SOA capability	Gen 1	Gen 2
Mode 1	FOM 1: FOM 2: Etc.	FOM 1: FOM 2: Etc.	FOM 1: FOM 2: Etc.
Mode 2	FOM 1: FOM 2: Etc.	FOM 1: FOM 2: Etc.	FOM 1: FOM 2: Etc.
Etc.	Etc.	Etc.	Etc.

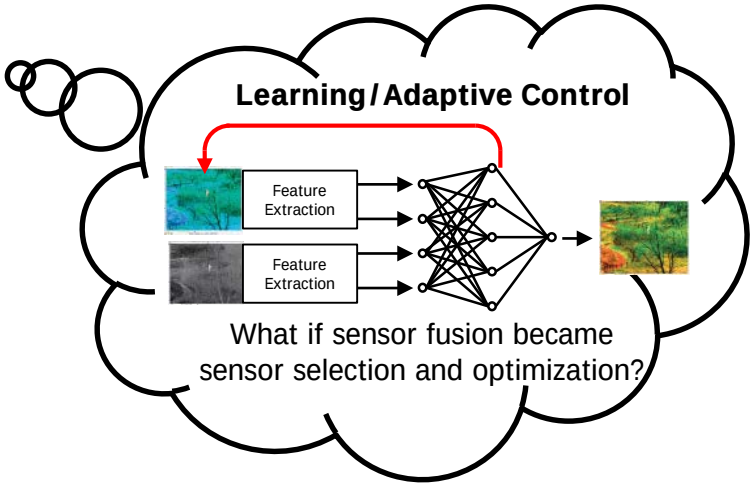
Helpful Hints for a Successful ReImagine TA1/2 Proposal

- Describe an application, notional system-level platform, and mission of interest
- Illustrate the benefits of the ReImagine architecture to the application and mission
- Detail the proposed modes of operation in the context of pixel-level, FPA-level, and system-level operations
- Define the principles or algorithms that control the modes of operation at a given time and location
- Provide the detailed description of the pixel-level design and features in Tier 2
- Provide a detailed description of the integration strategy, the prototype, and the final imaging demonstrations and test/validation strategy
- Delineate challenges and associated risk-mitigation strategies
- Describe innovative multi-functional modes of operation, embedded algorithms and/or autonomous control of functionality, and compare each mode of operation with the state of the art for a dedicated FPA designed specifically for that mode. These should be put in the context of relevant applications of interest to the DARPA mission. Priority should be given to concepts that demonstrate unprecedented capabilities based on reconfigurability.
- Specify a preliminary estimate of power
- Provide a detailed thermal analysis
- Describe a test strategy

Technical Area 3: Exploratory Concepts for Reconfigurable Imaging







TA3 performers will explore fundamental aspects of recursively configured sensor systems

Images from: doi:10.1167/8.14.21
doi:10.1117/1.3549928

ReImagine Program Structure

MIT-LL
Hardware and Software

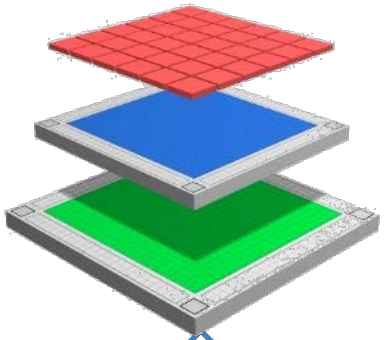
- Digital layer design
- Software development
- Design documentation

- Digital layer (Tier 1)
- Specification for Tier 1
- Verilog models for simulation of Tier 1
- Benchmark models
- FPGA CAD design flow
- Analog interface requirements
- Development kit

- Digital layer (Tier 1) requirements

TA 1&2 - Performers
Applications

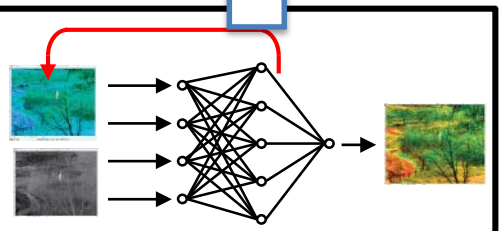
- Applications, algorithms, requirements
- Analog layer design, fabrication
- 3-D integration
- Phase 1 and 2 demonstrations



Applications of Multifunctional Imaging

TA 3 - Performers
Basic Research

- Concepts in imaging feedback systems, computational vision



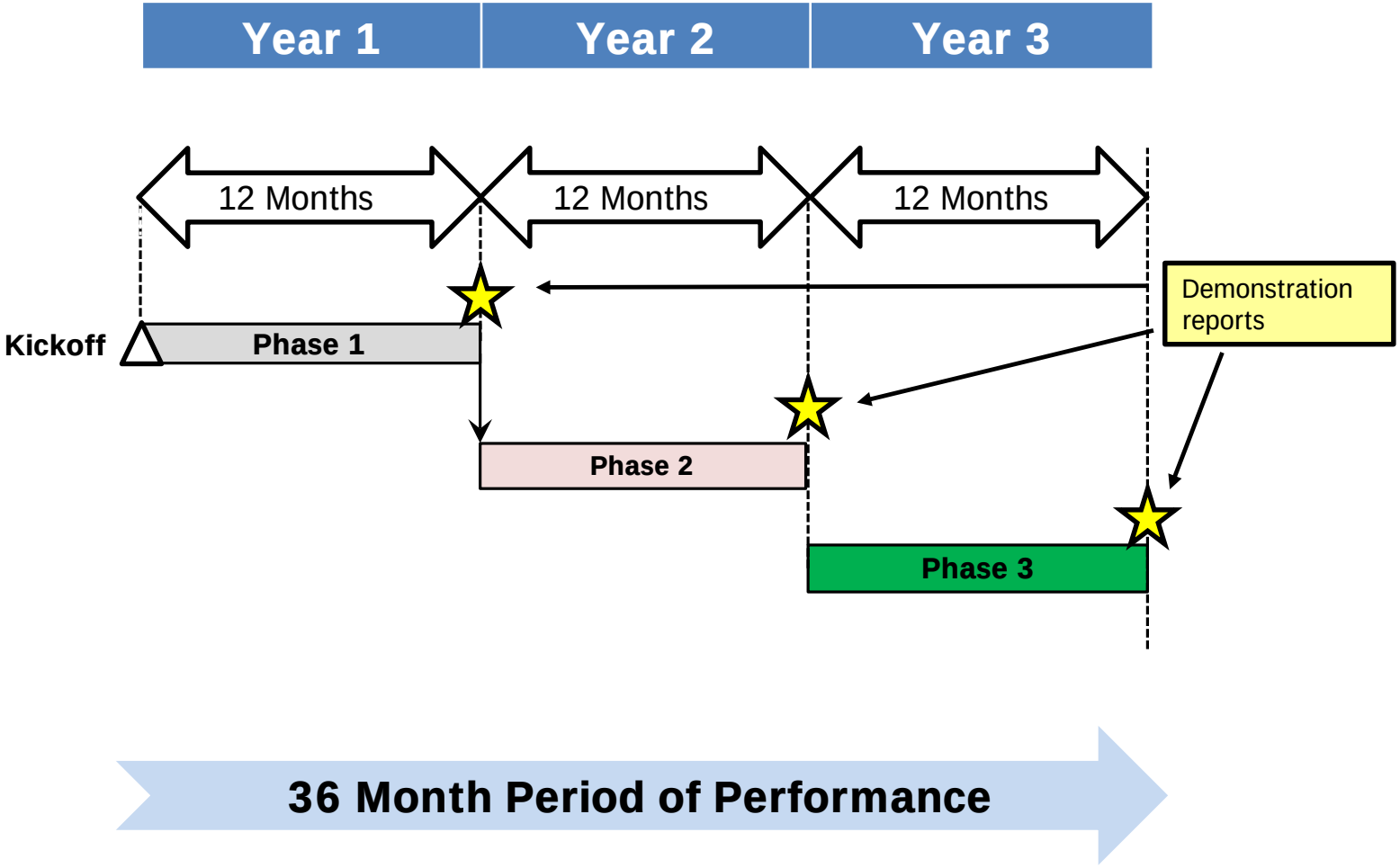
Helpful Hints for a Successful TA 3 Proposal

- Define a model for an adaptive learning algorithm that guides the acquisition of data from the sensor in real time
- Define the camera parameters to be used for adaptive reconfiguration of the sensor
- Specify how the proposed algorithm(s) will advance the capability of real-time adaptation to sensor data
- Specify objectively observable, measureable numerical metrics that will be used to demonstrate capability advancement
- Specify the test data sets used to quantify performance
- Describe implications of implementation on the size, weight, and power of the computation resources
- Provide specific quantitative milestones for the development of the algorithms
- Provide a clear description of the intended evaluation methodology

DARPA-defined specific objectives:

- For Phase 1, demonstrate streaming operation of the algorithm with a 1000x slowdown in real time
- For Phase 2, demonstrate of streaming operation of the algorithm with a 10x slowdown in real time
- For Phase 3, demonstrate a real-time camera model

TA 1/2 Timeline



Security Support for ReImagine (BAA-16-56)

Jaime-Maria R. Nelson
Program Security Representative
Microsystems Technology Office

Briefing for Industry

30 September 2016

Security Requirements for submitting classified reponses

- Proposals that address specific military applications may contain classified information

- Proposers submitting classified information must have, or be able to obtain prior to contract award:
  - Cognizant security agency approved facilities
  - Information systems
  - Appropriately cleared/eligible personnel to perform at the classification level proposed

- Submissions requiring DARPA to make a final classification determination shall be marked as follows:
  - "CLASSIFICATION DETERMINATION PENDING. Protect as though classified_____ (insert the recommended classification level, e.g., Top Secret, Secret or Confidential)"

Security coordination for classified responses

- Coordinate classified submissions via the BAA mailbox with the MTO Program Security Officer, Mr. David Stiffler
  - Collateral submission methods are listed in the BAA

- Proposers choosing to submit SAP information from an agency other than DARPA are required to provide the DARPA MTO PSO **written permission** from the source material's cognizant Special Access Program Control Officer (SAPCO) or designated representative
  - Contact the DARPA MTO PSO via the BAA mailbox or
  - DARPA SAPCO at 703-526-4102

- Refer to BAA-16-56 for full listing of security instructions

- Any questions please contact Jaime Nelson, PSR, 703-526-2281, jaime.nelson.ctr@darpa.mil

Reconfigurable Imaging (ReImagine) Program DARPA-BAA-16-56

Mark Jones
DARPA Contracts Management Office

Proposers Day
Arlington, VA
September 30, 2016

DISCLAIMER

If the BAA contradicts any information in these slides,

the BAA takes precedence.

BAA OVERVIEW

BAA follows procedures in accordance with FAR 35.016.

BAA (as well as any future amendments) is posted on FEDBIZOPPS at www.fbo.gov and Grants.gov at www.grants.gov

Proposals due by 5:00 pm ET on November 10, 2016

BAA covers all info needed to submit proposals. Follow instructions for proposal preparation and submittal.

POTENTIAL AWARD INFORMATION

DARPA anticipates multiple awards

Three Technical Areas (TAs) to propose against

TA1/2 structured in 3 phases over 45 months. TA3 structured in 3 phases over 36 months. For budgeting – tentative start date is April 1, 2017

Single proposal may address any or all TAs, but must fully address each TA proposed and separate tasks/costs between each TA.

Can receive awards for any TA – no conflicts

Awards may be Procurement Contracts, Grants/Cooperative Agreements (TA3 only) or Other Transaction Agreements

BAA ELIGIBILITY

All interested/qualified sources may respond subject to the parameters outlined in the BAA.

Foreign organization/individuals – check all applicable Security Regulations, Export Control Laws, Non-Disclosure Agreements, and any applicable governing statutes.

FFRDCs/UARCs and Government entities

- Subject to applicable direct competition limitations
- Must clearly demonstrate eligibility per BAA

Real and/or Perceived Conflicts of Interest

- Identify any conflict
- Include mitigation plan
- Be aware of Federal employment restrictions

PROPOSAL PREPARATION INFORMATION

Proposals consist of two volumes – Technical and Cost.

Volume 1 - Technical and Management

- Section II page limits vary depending upon the number of TAs proposed and whether it is for TA 1 or 2 vs. 3.
- Include one PowerPoint slide summarizing the proposal

Volume 2 – Cost - No page limit.

Include Attachment 1 Cost Volume Proposers Checklist

The BAA will describe the necessary information to address in each volume –

- Make sure to include every section identified and include any documentation specified.
- Include a working/unprotected spreadsheet as part of your Cost Volume submission.
- Review individual TA descriptions, IP rights, and the deliverables section for submittal information

STATEMENT OF WORK (SOW) PREPARATION TIPS

Write a SOW as if it were an attachment to an award

- Don't use proposal language (e.g. we propose to do . . .)
- Break out work between any phases/time periods identified in the BAA
- Succinctly and clearly define tasks & subtasks
- Identify measurable milestones and define deliverables
- Do not include any proprietary information!

NOTE: For grants or cooperative agreements: SOW = RDD or Research Description Document. For an OT, SOW = TDD or Task Description Document

PROPOSAL PREPARATION TIPS

- **Substantial Time Commitment**
  - Propose substantial time commitment for key personnel
  - If PI is committed to multiple projects, consider co-PI(s) or document mitigation efforts to make up for PI's lack of commitment to effort

- **Risk** – Do not be afraid to address Risk in Technical Volume
  - Identify risk(s) to show an understanding of technical challenge(s)
  - Discuss potential mitigation plans / alternative directions

Awareness of new terms & conditions

- DFARS Clause 252.203-7997 Prohibition on Contracting with Entities that Require Certain Internal Confidentiality Agreements
- DFARS Clause 252.204-7012 Safeguarding of Covered Defense Information and Cyber Incident Reporting

PROPOSAL PREP CONT'D – INTELLECTUAL PROPERTY RIGHTS

Government desires, at a minimum, **Government Purpose Rights** for any proposed noncommercial software and technical data. (SEE DFARS 227 for Patent, Data, and Copyrights)

Data Rights Assertions – IF asserting **less than Unlimited Rights**:

- Provide and justify basis of assertions
- Explain how the Government will be able to reach its program goals (including transition) within the proprietary model offered; and
- Provide possible nonproprietary alternatives

IF proposed solution utilizes commercial IP – submit copies of license with proposal

ITEMS TO NOTE

Work expected to be a mix of fundamental and non fundamental research

Understand and comply with SAM, E-verify, FAPIIS, i-Edison and WAWF. Links are found in the BAA.

For planning purposes - anticipated Program Start Date is April 1, 2017

Subcontracting Issues

- Non-Small Businesses: Subcontracting Plans required for FAR-based contracts expected to exceed the applicable threshold.
- Subcontractor cost - Proposals must include, at a minimum, a non-proprietary, subcontractor proposal for EACH subcontractor. Include any internal price/cost analysis of subcontract value in proposal.
- If utilizing FFRDC/UARC, Government entity, or a foreign-owned firm as a subcontractor, submit their required eligibility information, as applicable.

ITEMS TO NOTE CONTINUED

If a prospective proposer believes a conflict of interest exists or has a question on what constitutes a conflict - promptly raise the issue with DARPA

Document files must be in .pdf, .odx, .doc, .docx, .xls, and/or .xlsx formats

Submissions must be written in English

PROPOSAL SUBMISSION

Submit FAR based contract and OT proposals via DARPA's web-based upload system for unclassified portion of proposal. Submission must be in a single zip file not exceeding 50 MB.

Submit grant or cooperative agreement proposals via Grants.gov.

Follow submission procedures outlined in the BAA. DO NOT submit proposals except as outlined in the BAA (e.g., email/fax submissions will NOT be accepted).

DO NOT wait until the last minute to submit proposals – the submission deadlines as outlined in the BAA will be strictly enforced!

DO NOT forget to FINALIZE your proposal submission in the submission tool!

EVALUATION / AWARD

No common Statement of Work - Proposal evaluated on individual merit and relevance as it relates to the stated research goals/objectives

Evaluation Criteria (listed in descending order of importance) are: (a) Overall Scientific and Technical Merit; (b) Potential Contribution and Relevance to the DARPA Mission; (c) Proposer's Capabilities and/or Related Experience; and (d) Cost Realism.

Evaluation done by scientific/technical review process. DARPA SETAs with NDAs may assist in process.

Government reserves the right to select for award all, some, or none of the proposals received, to award portions of a proposal, and to award with or without discussions.

COMMUNICATION

Prior to Receipt of Proposals – No restrictions, however Gov't (PM/PCO) shall not dictate solutions or transfer technology. Unclassified FAQs will be periodically posted to this BAA's DARPA web page as indicated in the BAA.

After Receipt of Proposals – Prior to Selection: Limited to PCO – typical communication to address proposal clarifications.

After Selection/Prior to Award: Communications range from technical clarifications/revisions to formal cost negotiations. May involve technical as well as contracting staff.

Informal feedback for proposals not selected for funding may be provided once the selection(s), if any, are made.

Only a duly authorized Contracting Officer may obligate the Government

TAKE AWAY

Submit proposals before the due date/time - Do NOT wait until the last minute to submit.

Read and understand the BAA - Follow the BAA when preparing proposals.

Be familiar with Government IP terms from the DFARS Part 227.

Submit working/unprotected spreadsheet(s).

The Contracting Officer is the only Government official authorized to obligate the Government.

Thank You!