Heterogeneous Architectures for Quantum (HARQ)

Justin Cohen
Program Manager,
DARPA Microsystems Technology Office

Proposers Day
August 8, 2025


DARPA
HARQ
Heterogeneous Architectures for Quantum
Distribution Statement (A): Approved for public release. Distribution unlimited.

Welcome

Proposers Day Agenda

Start (ET)	Topic / Speaker
10:30	**WEBINAR CHECK-IN**
11:00	**Welcome** *Neal Oza/MTO Technical SETA*
11:05	**Introduction to MTO** *Whitney Mason, DARPA/MTO Office Director*
11:10	**Program Overview** *Justin Cohen, DARPA/MTO Program Manager*
12:10	**Contracting Overview** *Nestor GomezBello, DARPA/CMO Contracting Officer*
12:25	**Introduction to DARPAConnect** *Sana Hoda Sood, Applied Research Institute*
12:30	**BREAK**
13:30	**Question & Answer Session** *Justin Cohen, DARPA/MTO Program Manager*
15:00	**ADJOURN**

Security Introduction

Juan Cosme, DARPA/MTO Program Security Representative

Level and Topics

This meeting will be:

UNCLASSIFIED

- Classified discussions are **not permitted** during this conference!
- Security Topics
  - Security POCs

Security POCs

Program Solicitation (PS) Coordinator / General Contact: HARQ@darpa.mil

Program Security Representative (PSR) Contact: Grace 'SAL' Salcedo, Grace.Salcedo.ctr@darpa.mil

PSR Contact: Scott Rolston, Scott.Rolston.ctr@darpa.mil

Security Control Assessor (SCA) Contact: Andre Nelson, Andre.Nelson.ctr@darpa.mil

Note:

If needed, proposer's security team should contact the PSR and SCA through the PS email address, **HARQ@darpa.mil**, to initiate discussions as soon as company decides to propose to PS.

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15:00	**ADJOURN**

Question & Answer Session Guidance

- Questions must be **submitted by 12:30 PM ET** for today's Q&A Session
- Submit questions to **HARQ@darpa.mil**
- Questions not answered in the Q&A Session may be published in the Frequently Asked Questions (FAQ) document following today's event
- FAQ document will be posted at: **https://www.darpa.mil/research/programs/HARQ**

Submit Questions to HARQ@darpa.mil

Important Dates

Dates/Time: All Times are Eastern Time Zone (ET)

- **Abstract Due Date:** August 28, 2025, at 1:00 p.m.
- **Abstract Virtual Q&A Dates:** September 4–17, 2025
- **Notification of Intent to Propose:** October 1, 2025, at 5:00 p.m.
- **Question Submittal Closed:** October 1, 2025, at 5:00 p.m.
- **Proposal Due Date:** October 14, 2025, at 4:00 p.m.
- **Virtual Oral Presentation Dates:** October 22 – November 4, 2025
- **Estimated Period of Performance Start:** February 1, 2026

For more information go to https://www.darpa.mil/research/programs/HARQ

Introduction to MTO

Whitney Mason, DARPA/MTO Office Director

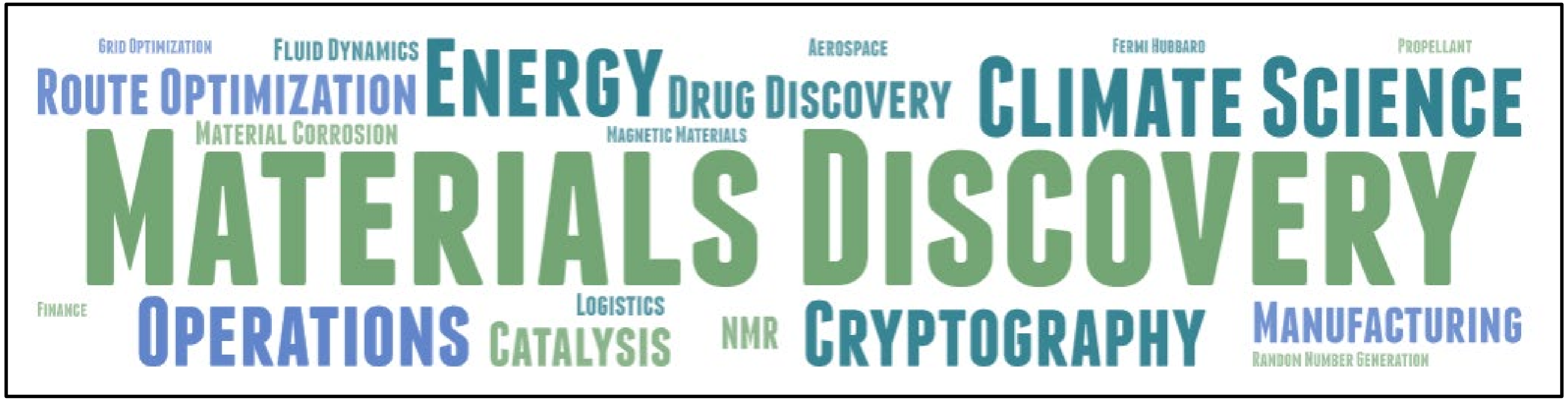
HARQ

Program Overview

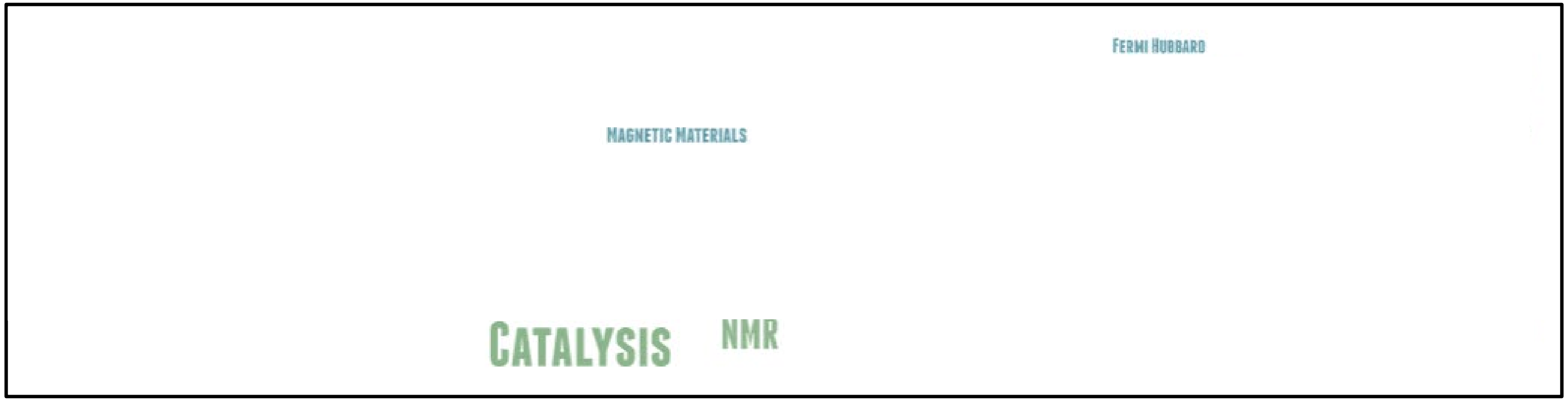
Justin Cohen, Program Manager
DARPA Microsystems Technology Office

Will quantum computing deliver on its promises?

There is a rich application space for quantum computers…



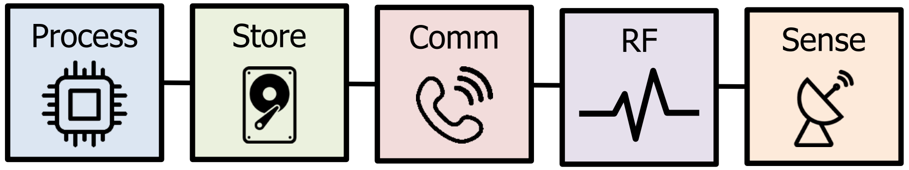
… but current industry roadmaps are targeting ≤ 1,000 logical qubits and leave many applications out of reach.



Quantum computing has a data movement problem

Lessons learned from 65 years of transistor scaling

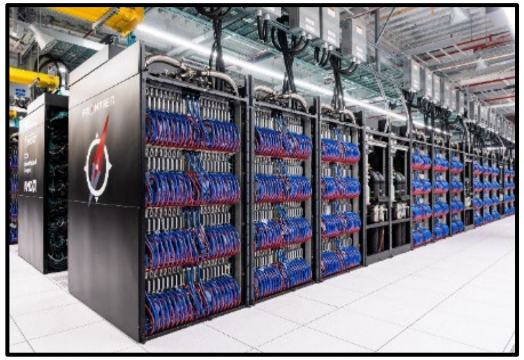
Diverse technologies enable high-performance with specialized capabilities, and small chips yield better than large chips



"best junction for the function"

Parallel architecture unlocks the highest performance

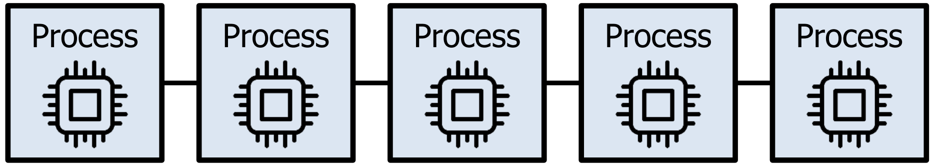
example: Frontier Supercomputer (2022)



Data movement drives scalability

How quantum computing is approaching qubit scaling today

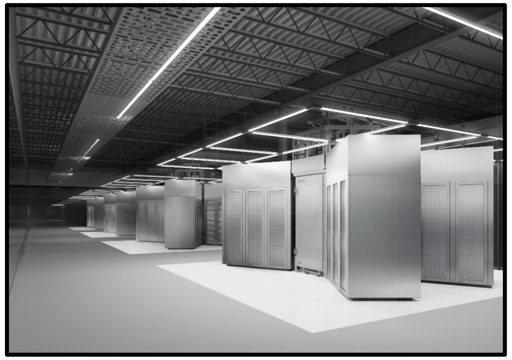
Combine as many qubits as possible in a module, and as many modules as possible in a system



"best bet on the qubit for all functions"

Build the largest system possible

example: IBM Blue Jay (planned for 2033)



Qubit physics dictates scalability

Implications of homogeneous architectures

	processing	memory	communication
trapped ions	~	✓✓	~
color centers	~	✓✓	✗
quantum dots	✓	~	✗
photons	~	✗✗	✓✓
neutral atoms	~	✓	~
superconducting circuits	✓✓	✗	~

No qubit is ideal for all functions

processing
memory
communication

Prediction – quantum computers in 2035

Software	Application	Corrosion Simulation; Magnetic Material Simulation; etc.
Software	Abstract Circuit	As Efficient As Possible
Software	Physical Circuit	Long Runtime
Hardware	Multi-Module System	Small
Hardware	Multi-Qubit Module	Small; High Connectivity
Hardware	Qubit	Nature's Qubits e.g., Neutral Atoms; Slow; Low Error

Systems with >>1,000 logical qubits will be:

prohibitively expensive to run,

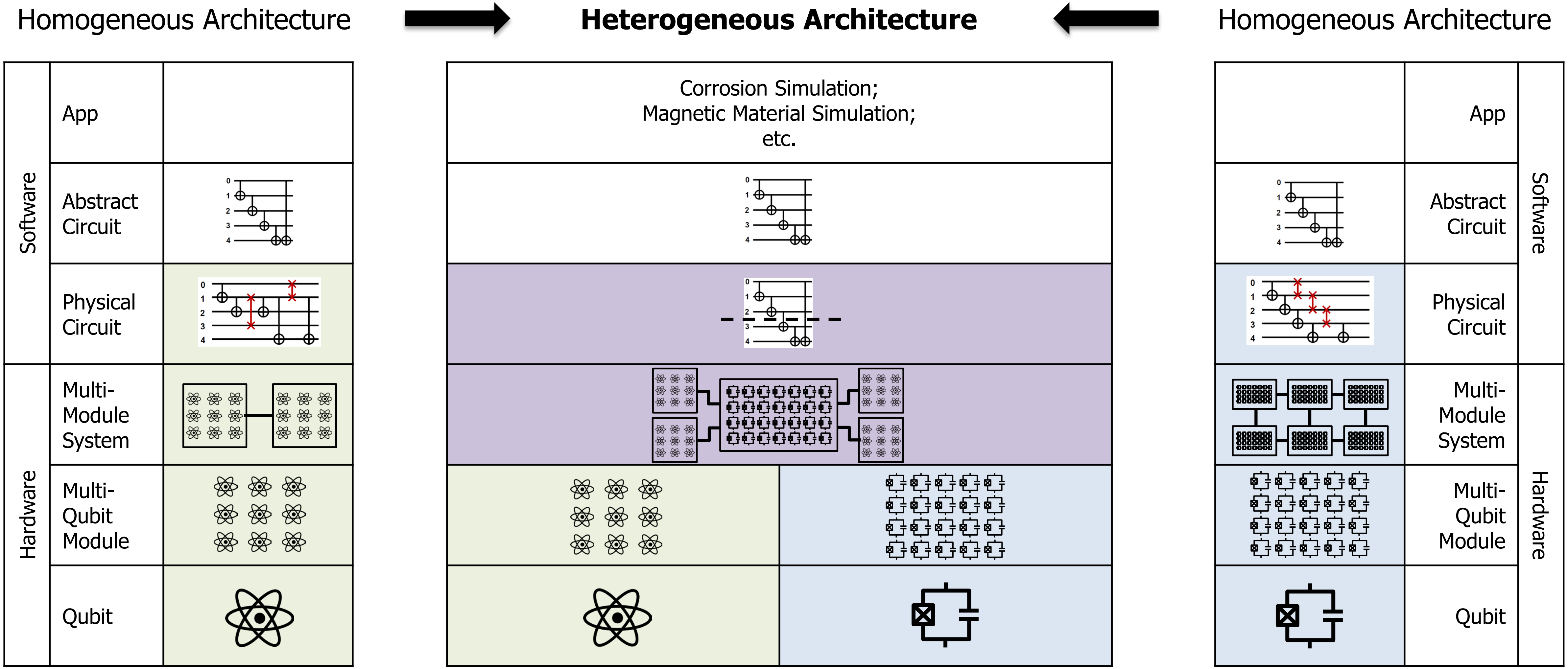
or,

prohibitively expensive to build.

Corrosion Simulation; Magnetic Material Simulation; etc.	Application	Software
As Efficient As Possible	Abstract Circuit	Software
Short Runtime	Physical Circuit	Software
Large	Multi-Module System	Hardware
Large; Low Connectivity	Multi-Qubit Module	Hardware
Manufactured Qubits e.g., Transmons; Fast; High Error	Qubit	Hardware

Grateful acknowledgement to Eric Bersin, MIT-LL, for articulating this hardware/software stack representation

What if we could have the best of both worlds?



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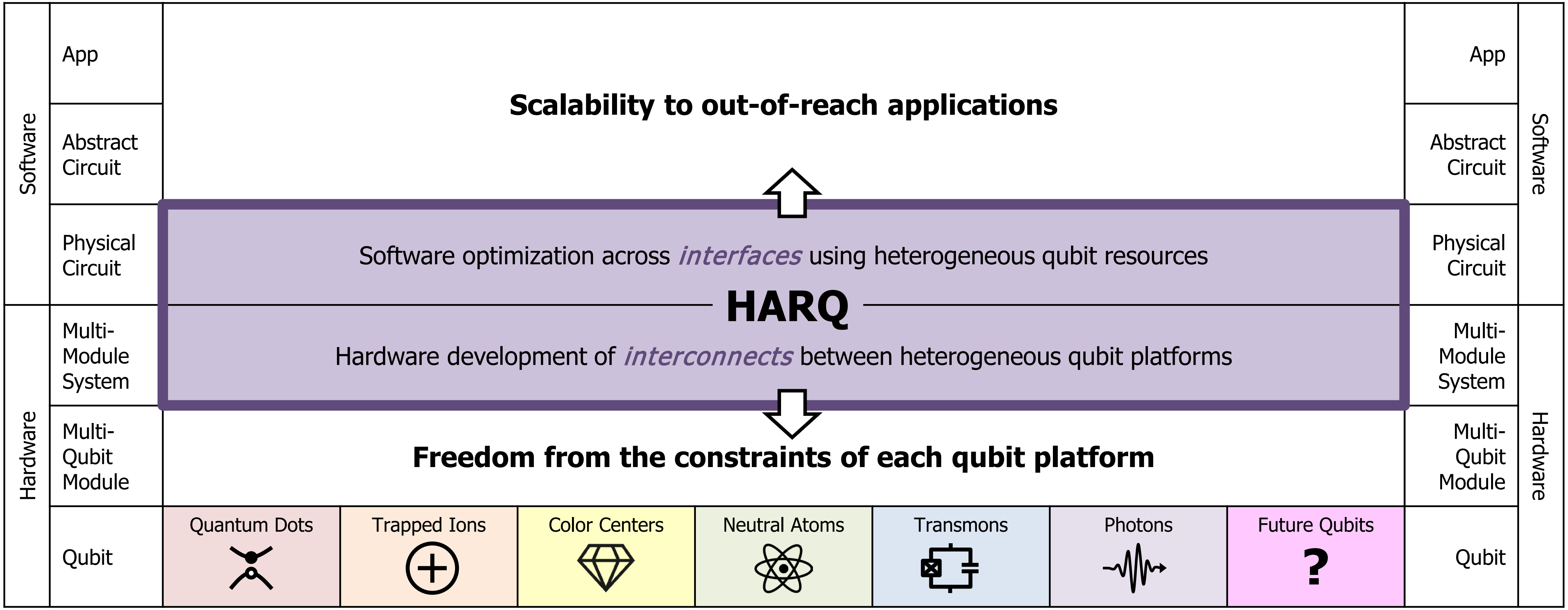
What if we could have the best of **all** worlds?

Heterogeneous Architecture



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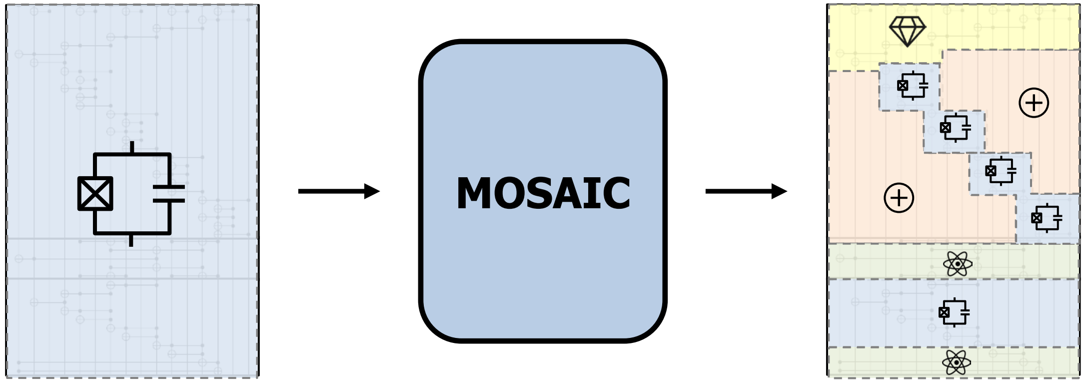
Heterogeneous architecture opens a new horizon for quantum computing

TA1
Multi-qubit Optimized Software Architecture through Interconnected Compilation (MOSAIC)



MOSAIC Hypothesis
Diversity of qubit parameters reduces resources for heterogeneous circuit compilations compared to homogeneous compilations

TA2
Quantum Shared Backbone (QSB)

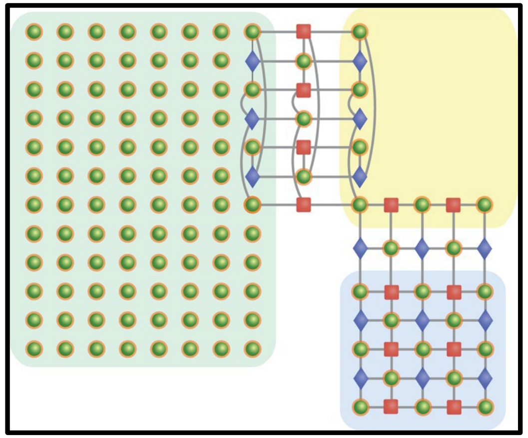
QSB Hypothesis
The advent of high-quality integration platforms enables quantum interconnects to approach the performance of intra-module operations

How do qubit species come together?

TA1: MOSAIC

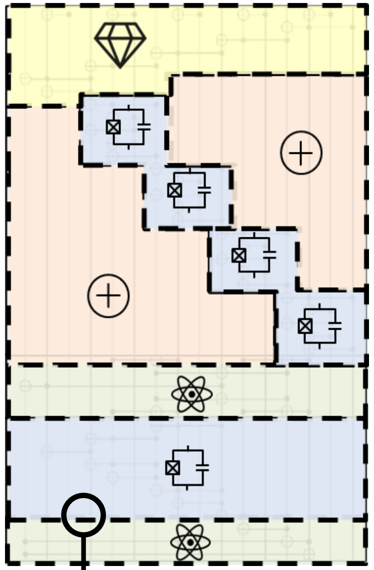
What could interfaces look like?

Homogeneous Example:
Quera teleportation scheme between qLPDC and surface code patches of neutral atom system



Xu et al. Nat. Phys. (2024)

Heterogeneous Example:
?



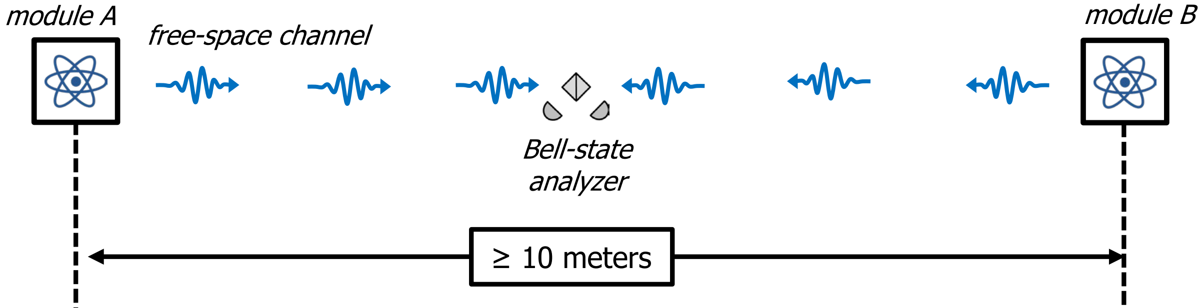
Heterogeneous Interface

Physical circuit layout that maps quantum information between one logical qubit to another logical qubit of a different species

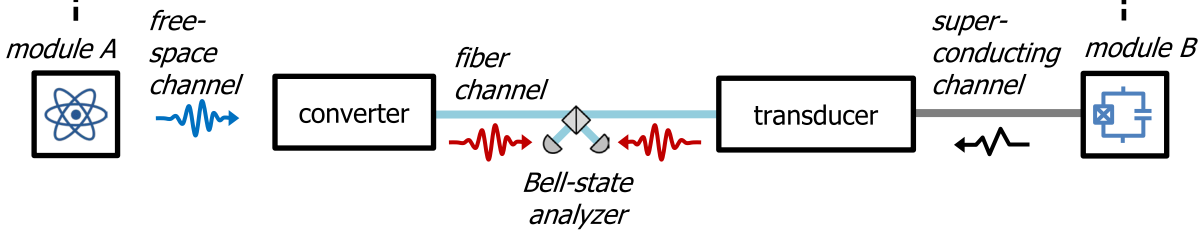
TA2: QSB

What could interconnects look like?

Homogeneous Example: Teleportation sequence between two neutral atom modules



Heterogeneous Example: Teleportation sequence between neutral atom and transmon modules



Heterogeneous Interconnect

Hardware component assembly that transfers the quantum state of one physical qubit to another physical qubit of a different species

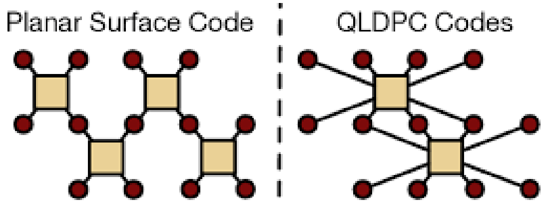
Technical Challenges

TA1

Challenges for interfaces

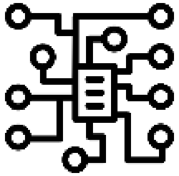
How to distribute operations between:

qubits with dissimilar error correction codes?



Vittal et al. IEEE/ACM MICRO (2024)

qubits with dissimilar connectivity?



qubits with dissimilar clock speed?

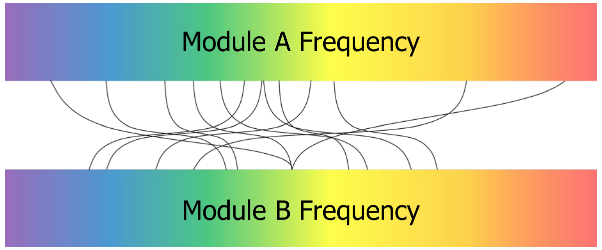
Will interfaces be manageable?
Which applications are amenable to heterogeneous architecture?
What is the "overhead"?

TA2

Challenges for interconnects

How to develop interconnects that are:

interoperable across operating frequencies and formats?

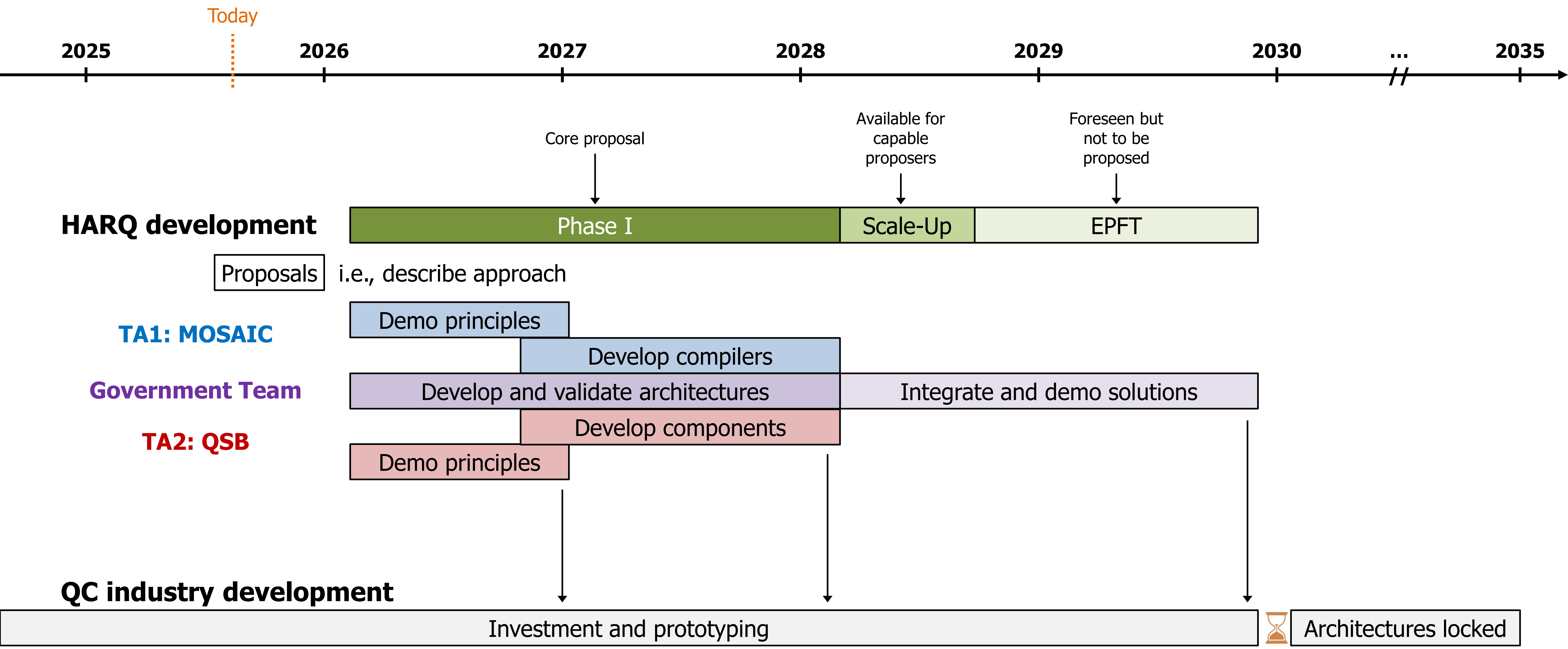


low noise or tolerant to noise?

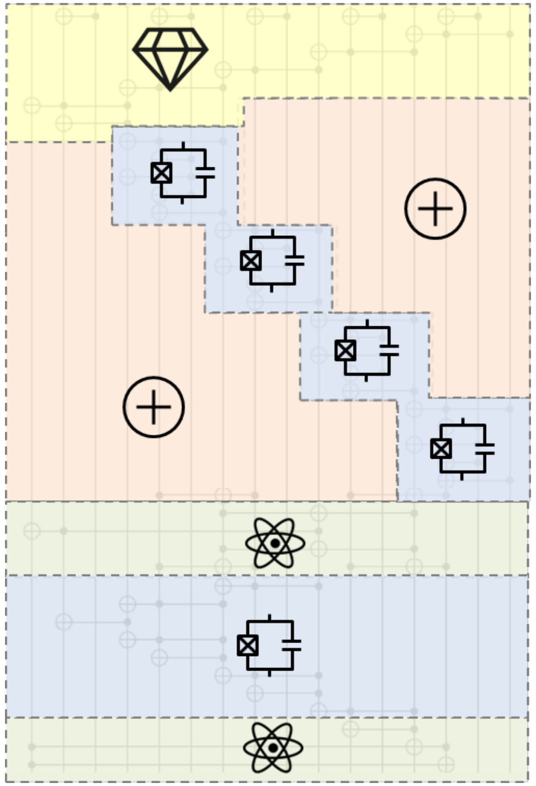
low loss or tolerant to loss?

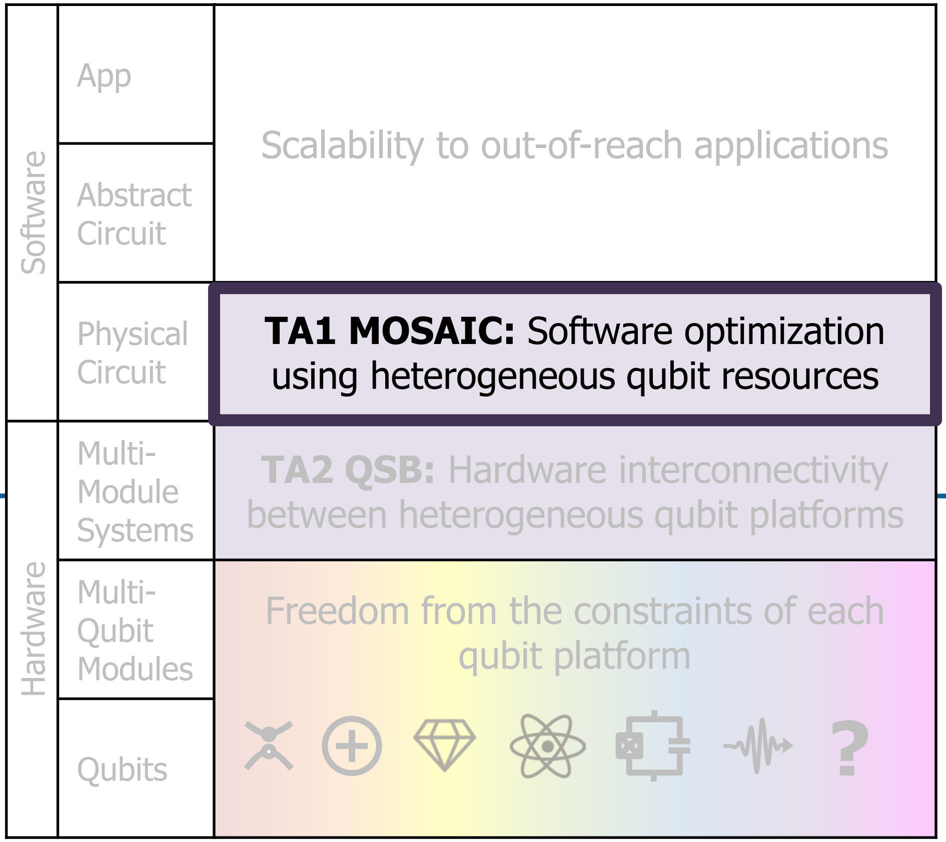
Will high rates and fidelities be achievable?
Which qubit species are amenable to heterogeneous architecture?
What is the "overhead"?

Timeline



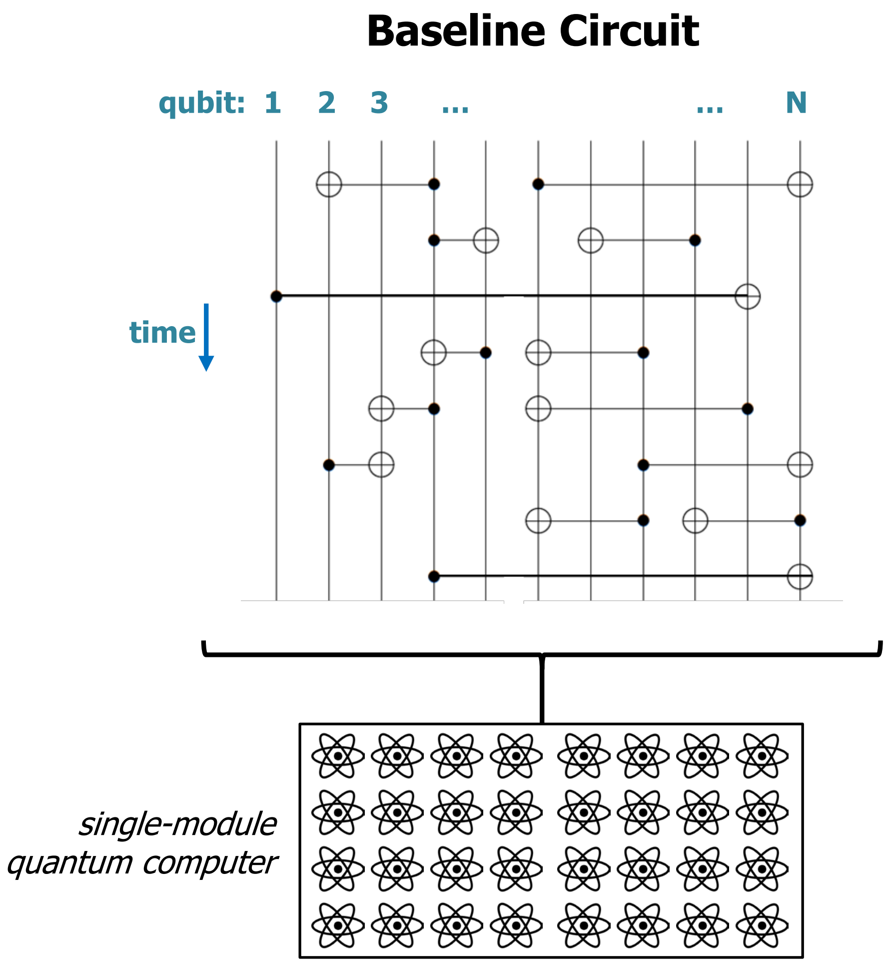
EPFT: Expanded Program Follow-on Tasking

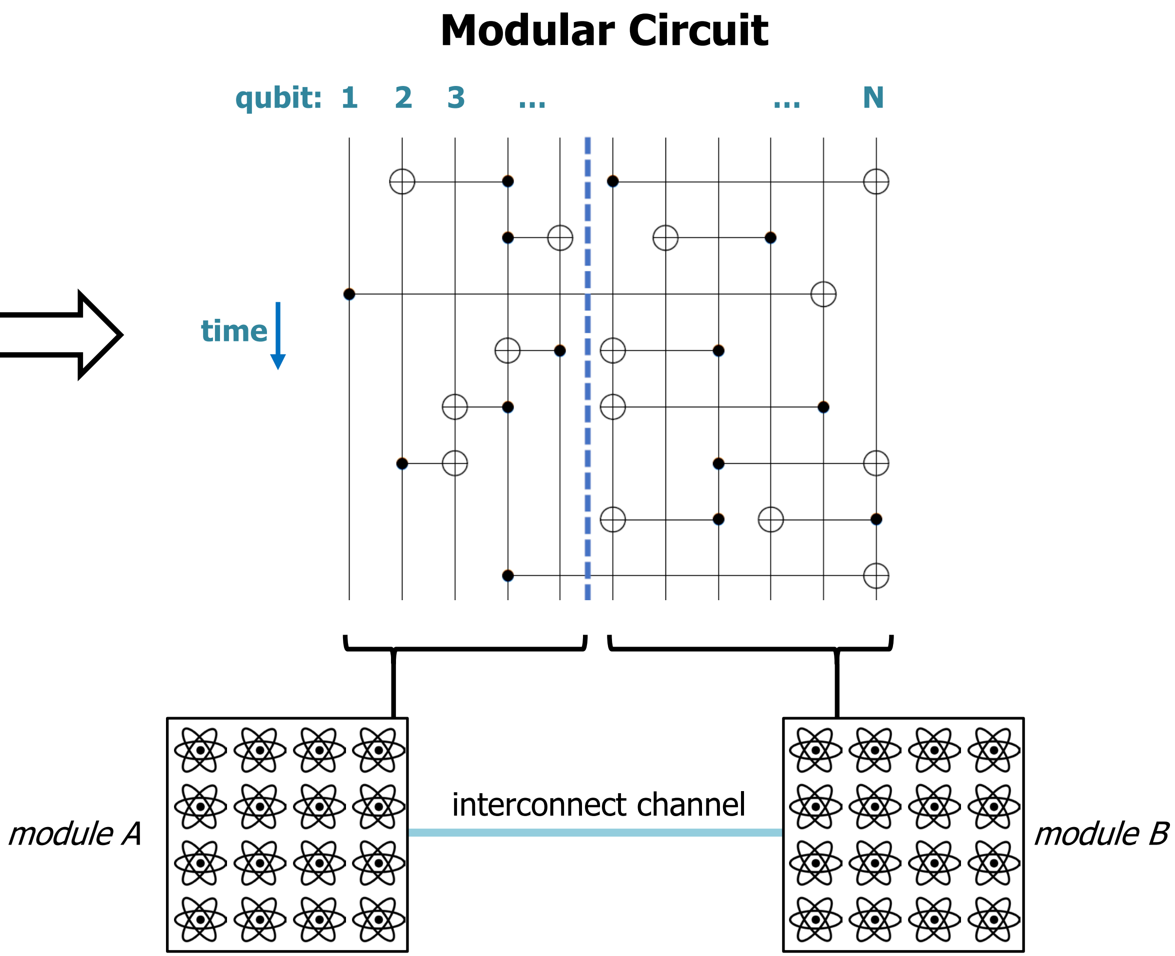




TA1: Multi-qubit Optimized Software Architecture through Interconnected Compilation (MOSAIC)

Modular approaches to scalable quantum computing





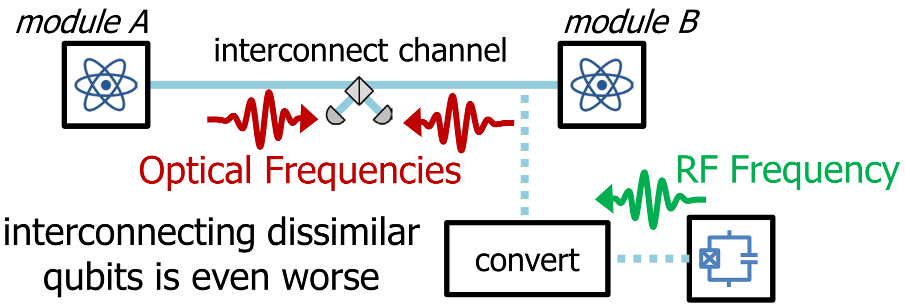
Works for small circuits

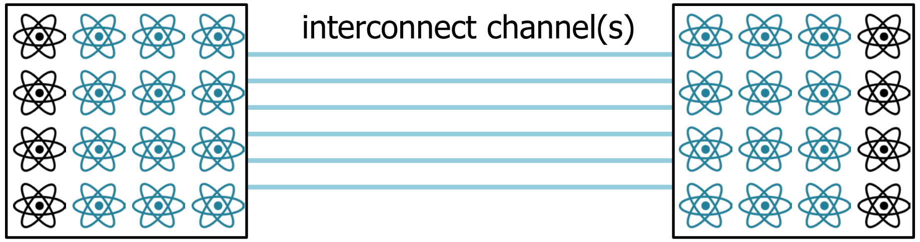
Solutions to scale past maximum module size

Circuit diagram modified from Pattison et al. ISCA (2025)

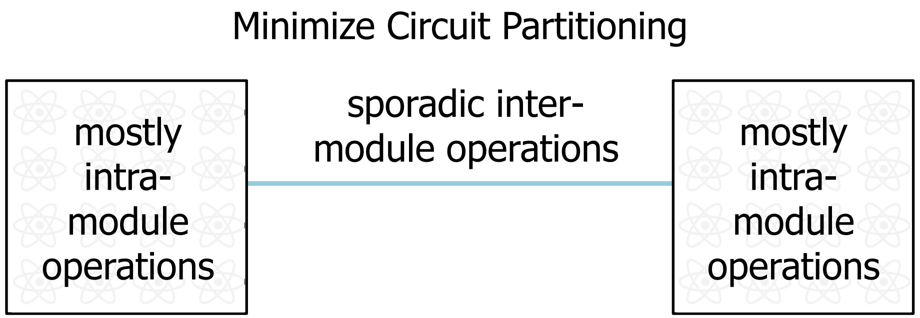
Hardware weaknesses constrain the software design space

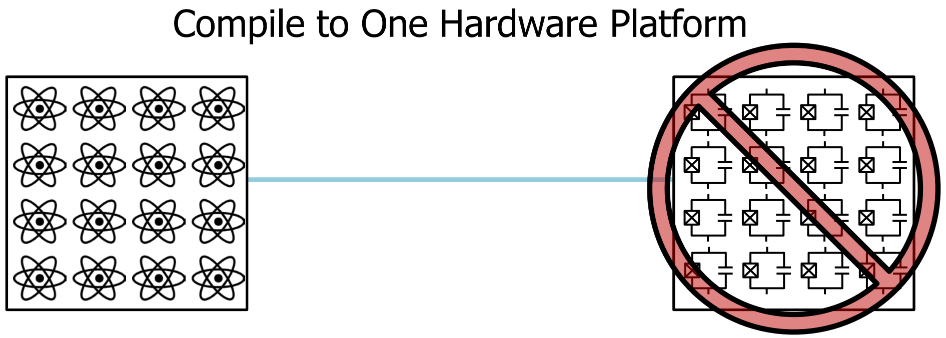
Interconnects are Slow, Low-Fidelity, and Cost Many Qubits





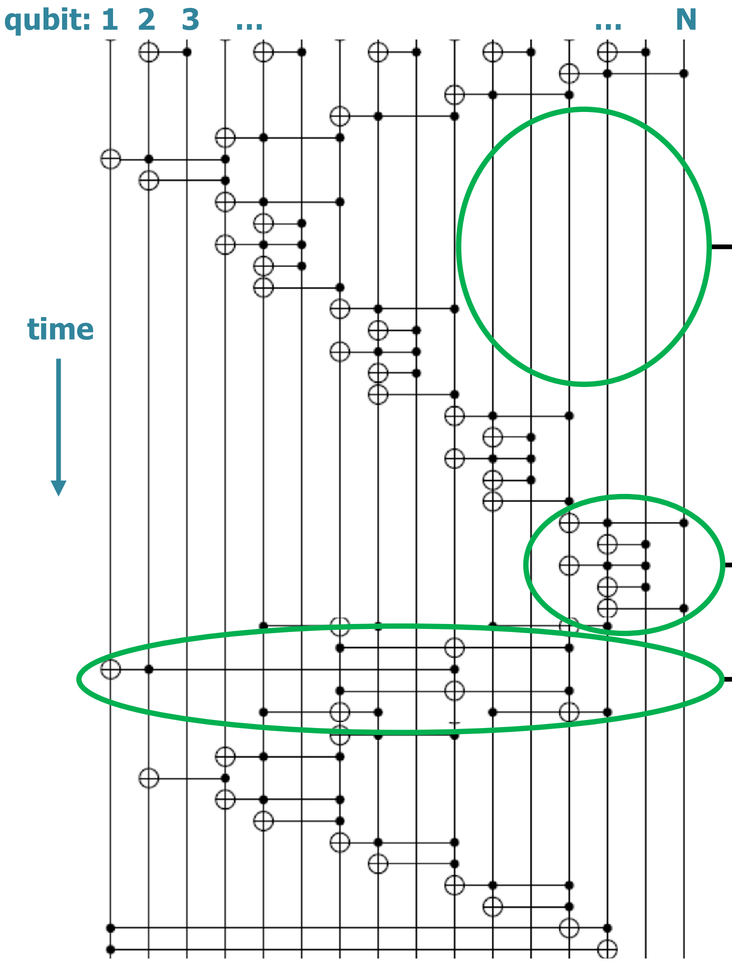
Impact on Today's Quantum Software Architecture





MOSAIC – exploring how to compile for communication AND qubit specialization

MOSAIC Input
Abstract circuit for Government-defined application



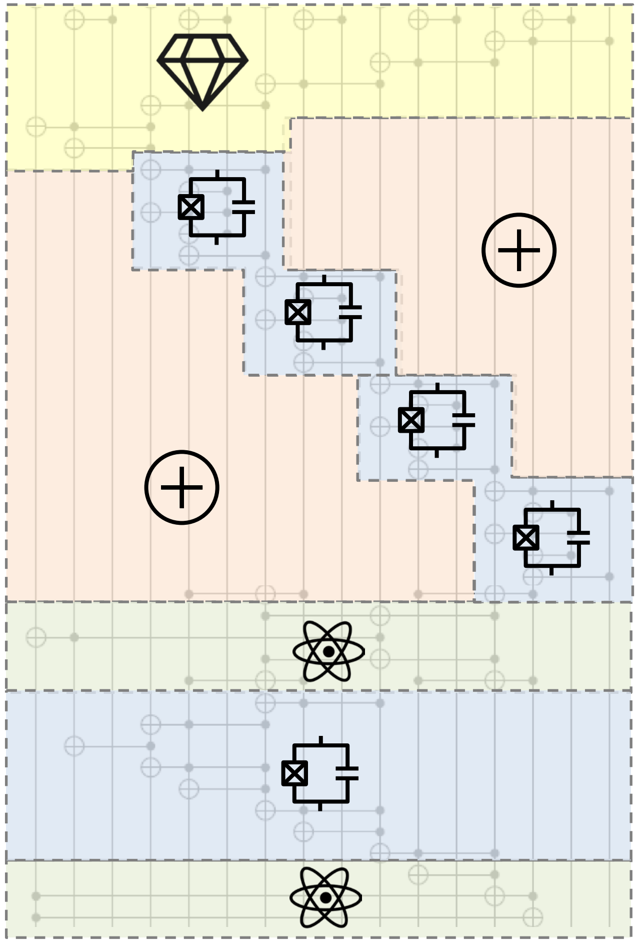
MOSAIC Technical Approaches
Methodology and compiler tools to optimize resources across diverse qubit resources

Example:
idle qubits: compile as trapped ions

dense gates: compile as transmons

long-range gates: compile as neutral atoms

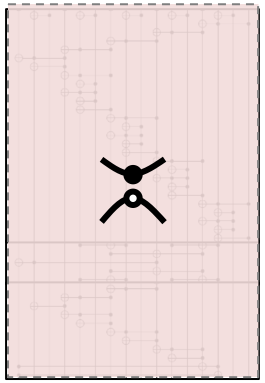
MOSAIC Output
Physical circuit compiled in heterogeneous architecture



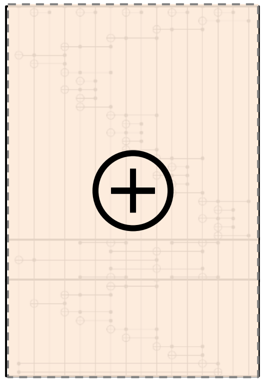
Circuit diagram modified from Kim et al. Appl. Sci. (2021)

MOSAIC – exploring how to compile for communication AND qubit specialization

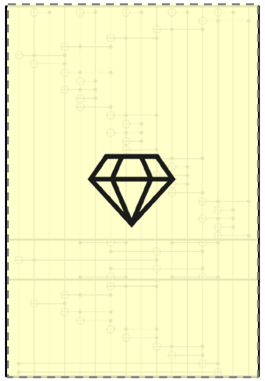
Homogeneous Reference Resource Estimates



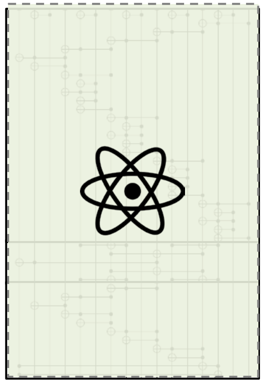
Quantum Dots
# qubits = N_1
runtime = T_1



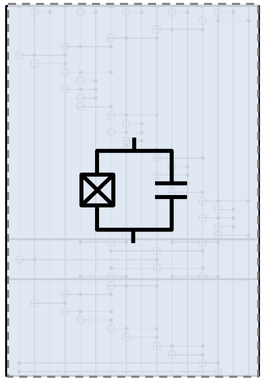
Trapped Ions
# qubits = N_2
runtime = T_2



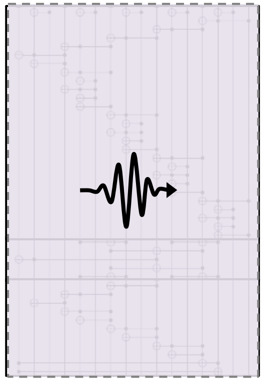
Color Centers
# qubits = N_3
runtime = T_3



Neutral Atoms
# qubits = N_4
runtime = T_4

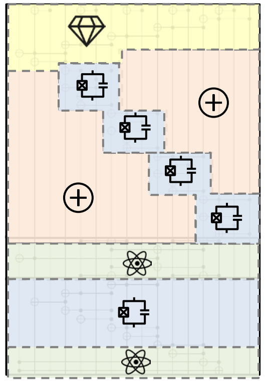


Transmons
# qubits = N_5
runtime = T_5



Photons
# qubits = N_6
runtime = T_6

MOSAIC Resource Estimates



Heterogeneous
# qubits = N
runtime = T

MOSAIC Hypothesis: Diversity in qubit parameters (code rates, clock speeds, connectivity, lifetime, etc.) can enable 1,000x lower resources for heterogeneous circuit compilations compared to homogeneous compilations

Resource Efficiency Function of N and T to be provided by Government Team during the program

Circuit diagram modified from Kim et al. Appl. Sci. (2021)

TA1 Metrics – Heterogeneous Compilers

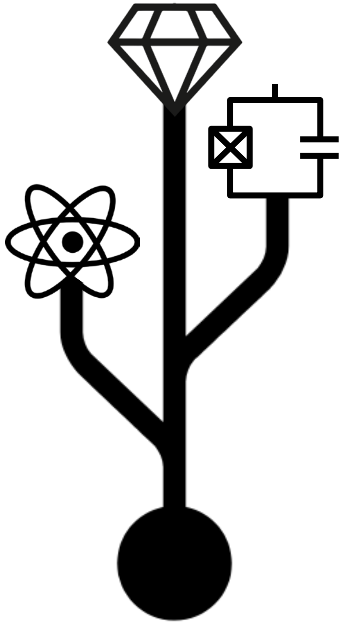
TA1	Compiler Metric
Resources	**1,000x lower than homogeneous compilations**
Circuit Size	**1,000 logical qubits**

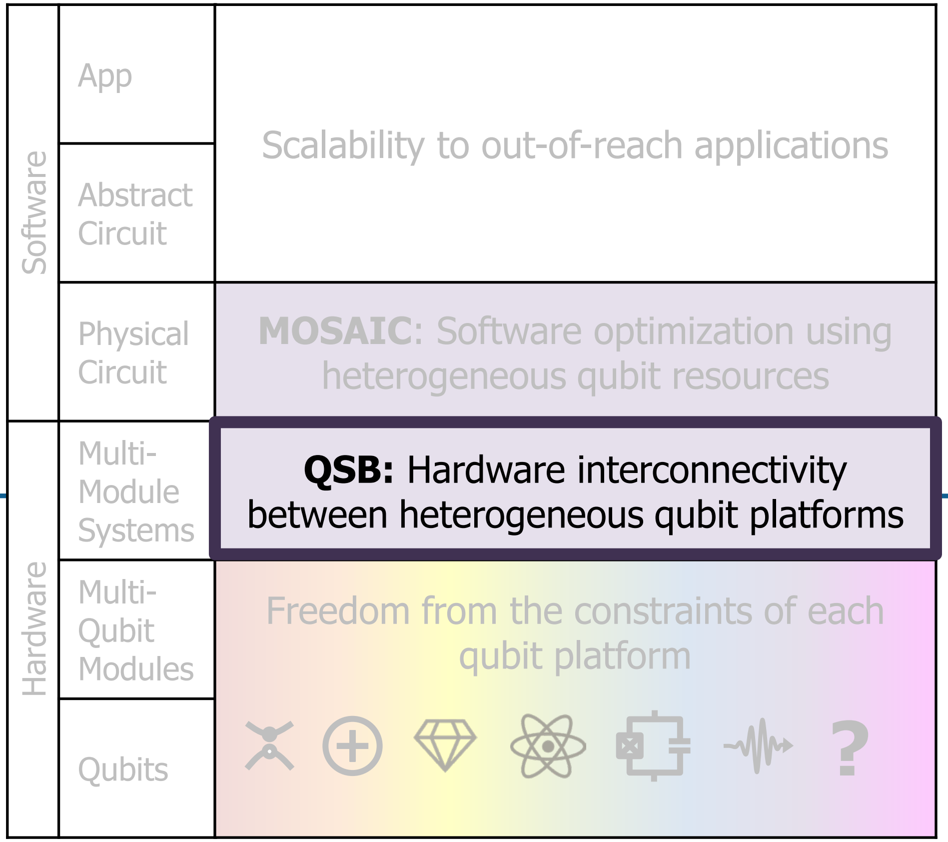
- Performers will calculate resources by plugging the physical circuit output of their compiler tool into a Government provided efficiency function that will assign weights to the number of physical qubits and operations for each qubit species within the circuit
  - Compiler tool will optimize resource allocations through the same function
  - The resource metric will be demonstrated by comparing the optimal heterogeneous compilation to the homogeneous compilations that the tool produces when constrained to single qubit species.
- The Government Team will benchmark the compiler tool on standardized reference circuits
- Performers must deliver the tool with sufficient documentation so that the Government Team can use and modify the tool to independently apply the optimization framework.

TA1 Metrics - Circuit Size

TA1	Compiler Metric
Resources	**1,000x lower than homogeneous compilations**
Circuit Size	**1,000 logical qubits**

- In Year 1, TA1 compilers will be benchmarked on small reference circuits,<10 logical qubits, provided by the Government Team
- In Year 2, the compilers tool must be extended to be capable of compiling circuits containing at least 1,000 logical qubits.
- Proposals will define initial optimization frameworks and a progression of theory, analysis, and software development efforts to develop the compiler tool
  - Narrative proposal: initial framework, interfaces, and compiler approach
  - Oral proposal: technical plan



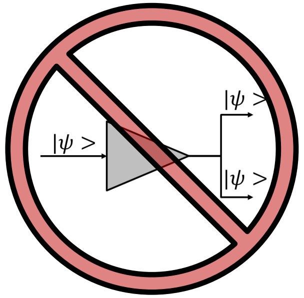


TA2: Quantum Shared Backbone (QSB)

The quantum communication problem

Quantum Information is Fragile

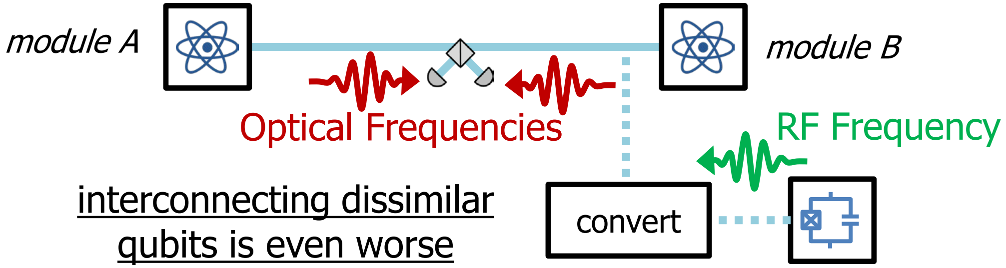
cannot be copied, only moved



loss decreases rate

noise decreases fidelity

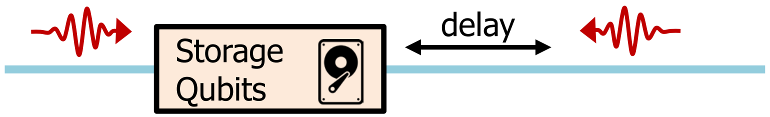
Impact on Today's Interconnects:
teleportation-based transfer is 1,000x slower
and 100x lower fidelity than intra-module operations



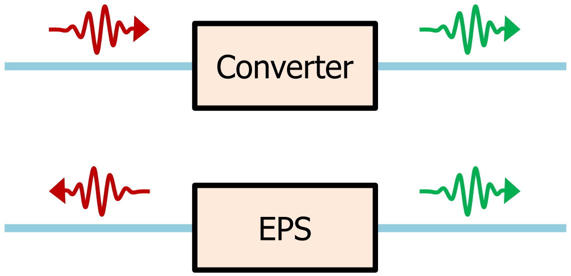
Impact on Today's Quantum Hardware Architecture:
cannibalize processing qubits to boost interconnects,
connect the same qubits on either end

TA2 Tracks – Building blocks for new modes of quantum communication

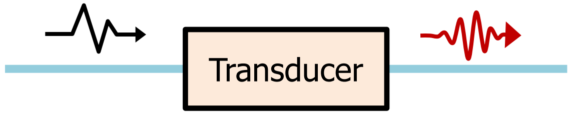
A: Quantum memories or repeaters



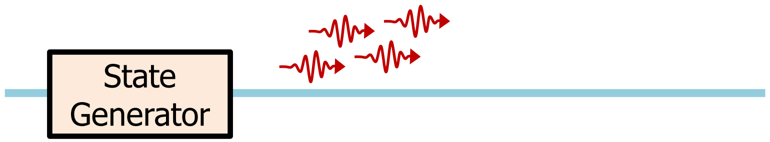
B: Optical frequency converters or entangled photon sources



C: Microwave-to-optical transducers



D: Alternative components and/or interconnects

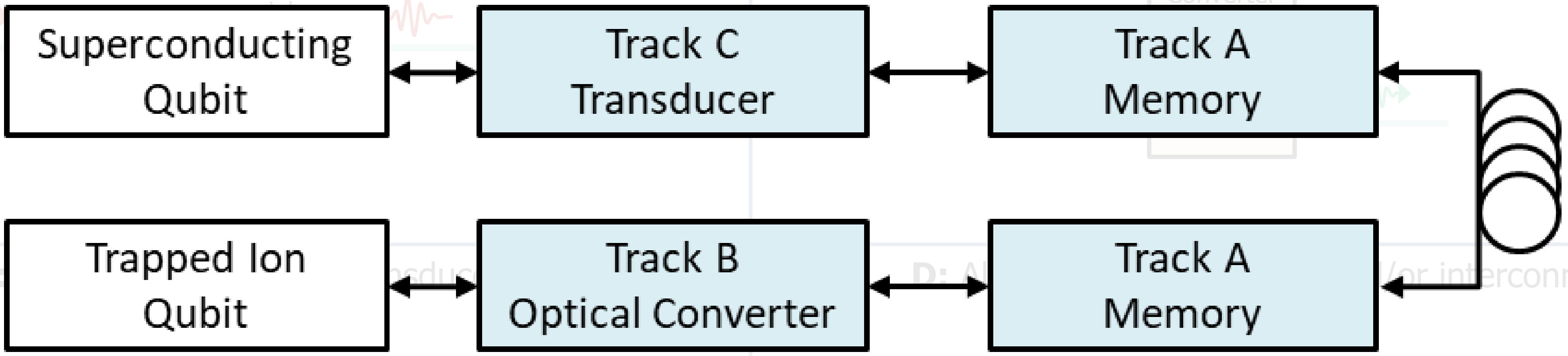


TA2 Tracks – Building blocks for new modes of quantum communication

A: Quantum memories or repeaters

B: Optical frequency converters or entangled photon sources

Example interconnect scheme (illustrative purposes only)



QSB Hypothesis: Components built from high-quality integration platforms enable quantum interconnects to approach the performance of intra-module operations

TA2 Metrics

TA2	Interconnect Metric
State Transfer Rate	**10 MHz**
State Transfer Fidelity	**99.9%**

- **Proposers must define component metrics that trace to the program interconnect metrics**
- Interconnect metrics are to be met between a single physical qubit in module A and a single physical qubit in module B, for any pairwise combination of end-node qubit species A and B
- Interconnect metrics do not include the response time and infidelity of end-node qubit processes
- Interconnect model must account for at least 10-m-long physical communications channel
  - Model will be updated throughout program based on other findings across TA1 and TA2
- Proposals will define initial component designs and a progression of fabrication, assembly, and experimental tests to demonstrate the functionality
  - Narrative proposal: component and interconnect performance analysis
  - Oral proposal: technical plan

TA2 Metrics

TA2	Interconnect Metric
State Transfer Rate	**10 MHz**
State Transfer Fidelity	**99.9%**

Baseline Performance

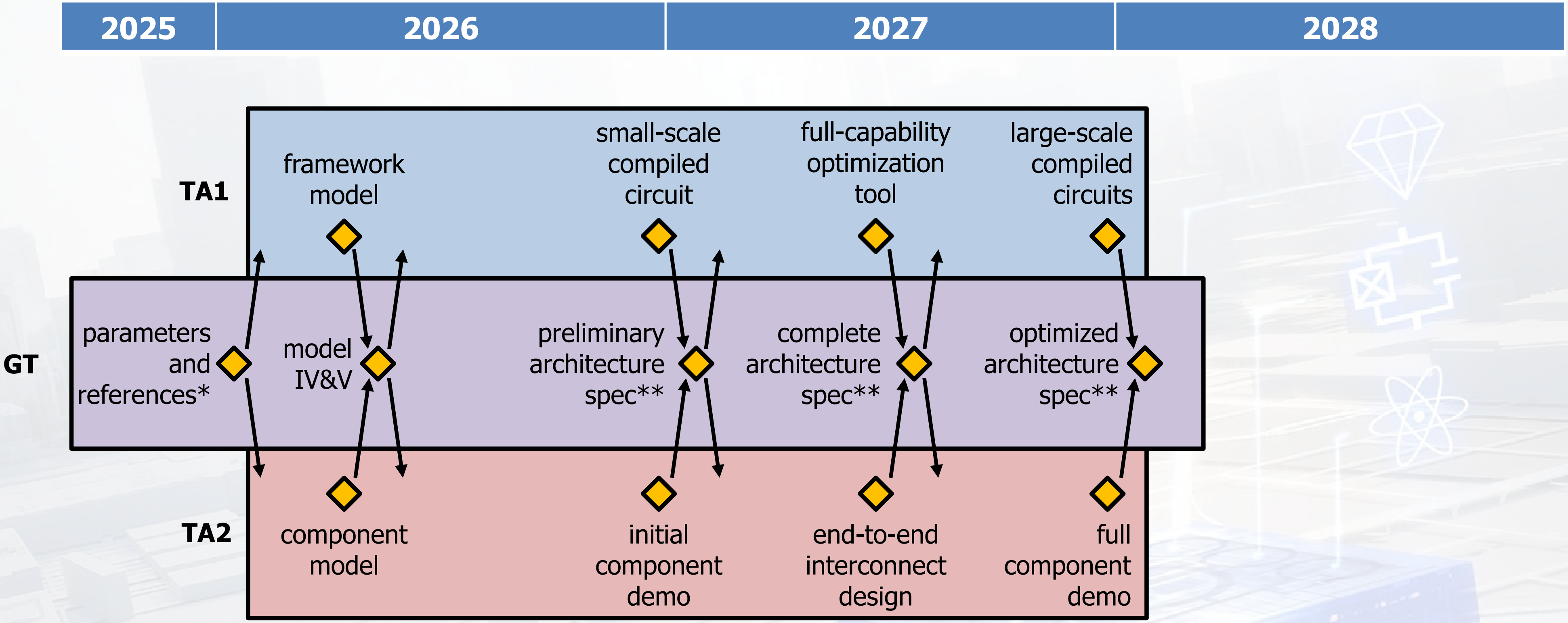
- Specification that can be rigorously substantiated through analysis of the proposed design
- Interconnect model may assume state-of-the-art performance for other components of the interconnect

Target Performance

- Estimate of the theoretically achievable performance if all proposed innovations succeed
- Interconnect model may involve novel functionality or performance beyond performance for other components of the interconnect

Technical Interchange and Government Team

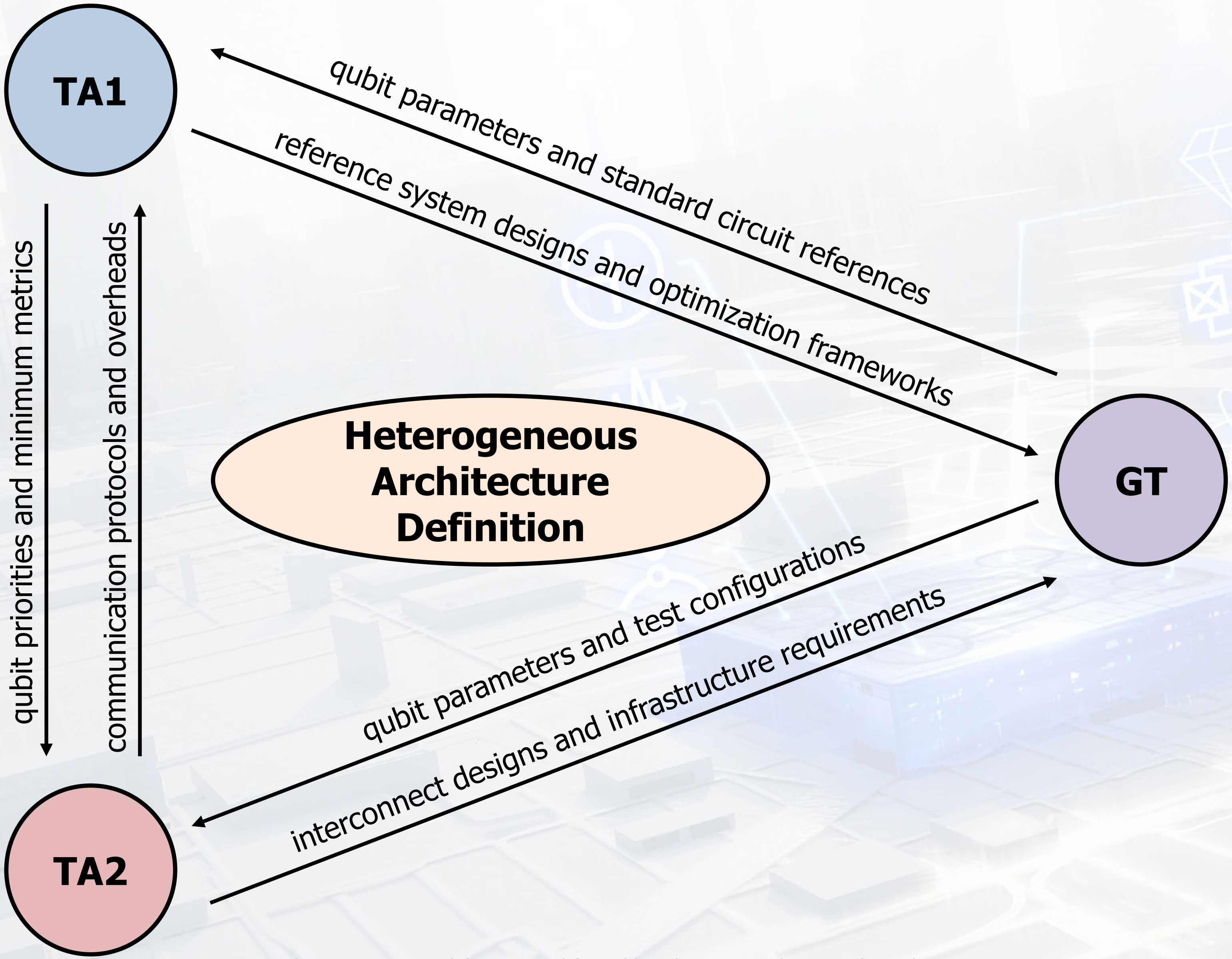
HARQ Technical Interchange Data Flow



* Qubit parameters, small-scale reference circuits < 100 qubits, and large-scale reference circuits > 1,000 qubits
** QC architecture design and technoeconomic analysis

GT: Government Team
IV&V: Independent Verification and Validation
QC: Quantum Computing
TA: Technical Area

Quarterly Technical Interchange Meetings



TA1 Government Team Tasks

1. **Definition of representative qubit parameters**: Analyze and extrapolate the state-of-the-art qubit parameters, including coherence time, gate speed, gate fidelity, code rate, etc.
2. **Definition of reference circuits for quantum algorithm compiler tools:** Identify small-scale and large-scale test circuits for evaluating the scalability of distributed heterogeneous QC vs distributed homogeneous QC.
3. **Development of modeling and simulation tools to study distributed QC architectures:** Analyze distributed QC architectures and interconnect topologies to understand achievable performance benefits
4. **Independent operation of performer compiler tools:** Conduct independent verification and validation (IV&V) and test and evaluation (T&E); adapt and apply compilation optimization frameworks to DoD relevant applications
5. **Heterogeneous QC architecture development and resource estimation:** Refine concepts for heterogeneous architectures and provide feedback to DARPA and HARQ performers to guide their designs

TA2 Government Support Tasks

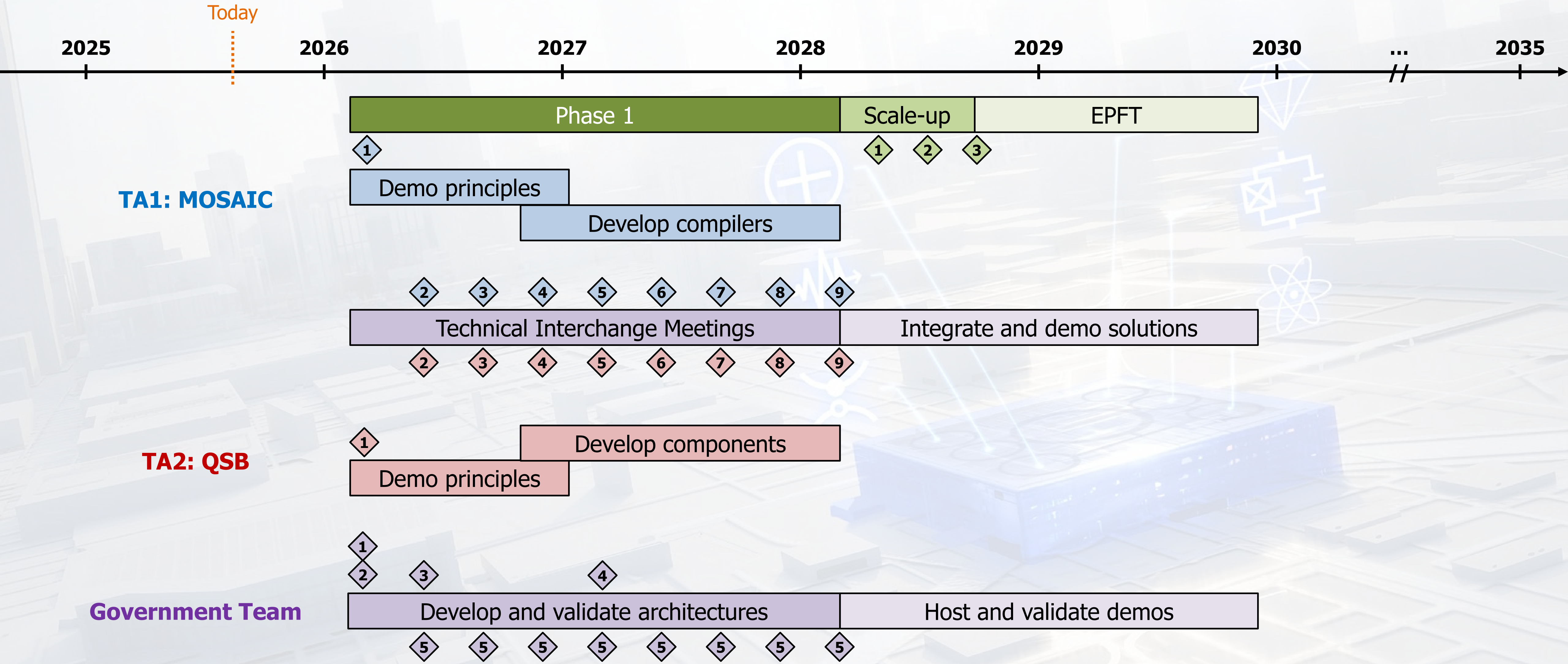
1. **Interconnect component test and evaluation:** Conduct independent T&E of device components
2. **End-to-end interconnect test design:** Develop testing protocols for operating heterogeneous interconnect with components developed by performers
3. **Interconnect component development:** Perform limited scope development of key components for interconnect demonstrations

Program-Wide Government Support Tasks

1. **Technoeconomic analysis for heterogeneous QC systems**: Analyze the commercial and economic impacts if heterogeneous architectures do provide significant scaling advantages
2. **Engagement with QC industry:** Provide the QC industry with insight into the results of HARQ, and solicit feedback from the QC industry to guide the implementation of HARQ technology
3. **Technical workshop management and participation for program-wide technical interchange:** Conduct workshop-style program meetings to combine the findings of TA1 and TA2 to guide the development of heterogeneous architecture concepts.
4. **Technical advising during regular project review meetings:** Participate in quarterly technical review meetings with multiple performers and provide technical feedback to performers and DARPA.

Program Timeline and Milestones

HARQ Timeline



EPFT: Expanded Program Follow-on Tasking

TA1: MOSAIC Milestones

Milestone		Month	Exit Criteria/Deliverable	Payment*
1	Initial Optimization Framework and Kickoff	1	• Kickoff presentation slides • Documentation of initial optimization framework in Government-specified format • Executed ACAs with all other TA1 and TA2 performers	$50,000
2	Initial Interface Layout	3	• Interface circuit layout for one combination of Government-defined qubit parameters • Revision of optimization framework based on Government feedback and delivery of revised documentation • Presentation delivered at virtual TIM that updates Government Team on detailed technical R&D progress • Presentation delivered at virtual TIM that updates a program-wide audience on the necessary optimization framework details for architecture development	$200,000
3	Framework Revision	6	• Revision of optimization framework based on Government feedback and delivery of revised documentation • Presentation delivered at in-person TIM that updates Government Team on detailed technical R&D progress • Presentation delivered at in-person TIM that updates a program-wide audience on the necessary optimization framework details for architecture development • Summary of findings from coordination with TA2 and Government Team at in-person TIM	$275,000
4	Intermediate Interface Layouts	9	• Interface circuit layout for all combinations of Government-defined qubit parameters • Revision of optimization framework based on Government feedback and delivery of revised documentation • Presentation delivered at virtual TIM that updates Government Team on detailed technical R&D progress • Presentation delivered at virtual TIM that updates a program-wide audience on the necessary optimization framework details for architecture development	$200,000
5	Small-Circuit Demo	12	• Demonstration of optimization framework on small benchmark circuits • Revision of optimization framework based on Government feedback and delivery of revised documentation • Presentation delivered at in-person TIM that updates Government Team on detailed technical R&D progress • Presentation delivered at in-person TIM that updates a program-wide audience on the necessary optimization framework details for architecture development • Summary of findings from coordination with TA2 and Government Team at in-person TIM	$275,000

** Payments listed for each milestone are not-to-exceed amounts.*

TA1: MOSAIC Milestones

Milestone		Month	Exit Criteria/Deliverable	Payment*
6	Initial Compiler Tool Code	15	• Demonstration of functional compiler tool code • Revision of optimization framework based on Government feedback and delivery of revised documentation • Presentation delivered at virtual TIM that updates Government Team on detailed technical R&D progress • Presentation delivered at virtual TIM that updates a program-wide audience on the necessary optimization framework details for architecture development	$200,000
7	Version 1 Compiler	18	• Delivery of first version of the compiler tool code to Government team • Revision of optimization framework based on Government feedback and delivery of revised documentation • Presentation delivered at in-person TIM that updates Government Team on detailed technical R&D progress • Presentation delivered at in-person TIM that updates a program-wide audience on the necessary optimization framework details for architecture development • Summary of findings from coordination with TA2 and Government Team at in-person TIM	$300,000
8	Large-Circuit Demo	21	• Software demonstration of optimization framework on Government-provided large benchmark circuit • Revision of optimization framework based on Government feedback and delivery of revised documentation • Presentation delivered at virtual TIM that updates Government Team on detailed technical R&D progress • Presentation delivered at virtual TIM that updates a program-wide audience on the necessary optimization framework details for architecture development	$200,000
9	Optimized Circuit and Resource Estimate	24	• Optimization results and detailed resource estimate for Government-provided large benchmark circuit • Delivery of updated version of the compiler tool code to Government team • Revision of optimization framework based on Government feedback and delivery of revised documentation • Presentation delivered at in-person TIM that updates Government Team on detailed technical R&D progress • Presentation delivered at in-person TIM that updates a program-wide audience on the necessary optimization framework details for architecture development • Prototype Delivery: proof-of-concept software tool and a proof-of-concept model • Final Report (End of Phase Report)	$300,000

** Payments listed for each milestone are not-to-exceed amounts.*

TA2: QSB Milestones

Milestone		Month	Exit Criteria/Deliverable	Payment*
1	Initial Designs and Kickoff	1	• Kickoff presentation slides • Documentation of initial component-level and interconnect-level designs in Government-specified format • Orders-placed for long-lead purchase items • Executed ACAs with all other TA1 and TA2 performers	$250,000
2	Design Revision 1	3	• Revision of component design based on Government feedback and delivery of revised documentation • Presentation delivered at virtual TIM that updates Government Team on detailed technical R&D progress • Presentation delivered at virtual TIM that updates a program-wide audience on the necessary component details for architecture development	$175,000
3	Initial Interconnect Models	6	• Interconnect designs for all combinations of Government-defined qubit parameters • Revision of component design based on Government feedback and delivery of revised documentation • Presentation delivered at in-person TIM that updates Government Team on detailed technical R&D progress • Presentation delivered at in-person TIM that updates a program-wide audience on the necessary component details for architecture development • Summary of findings from coordination with TA1, other TA2 tracks, and Government Team at in-person TIM	$200,000
4	Draft Interface Control Document	9	• Draft interface control document • Revision of component design based on Government feedback and delivery of revised documentation • Presentation delivered at virtual TIM that updates Government Team on detailed technical R&D progress • Presentation delivered at virtual TIM that updates a program-wide audience on the necessary component details for architecture development	$175,000

** Payments listed for each milestone are not-to-exceed amounts.*

TA2: QSB Milestones

Milestone		Month	Exit Criteria/Deliverable	Payment*
5	Initial Testing	12	• Experimental test results demonstrating underlying component features • Detailed analysis of interconnect-level performance and outlook based on underlying component feature performance • Revision of component design based on Government feedback and delivery of revised documentation • Presentation delivered at in-person TIM that updates Government Team on detailed technical R&D progress • Presentation delivered at in-person TIM that updates a program-wide audience on the necessary component details for architecture development • Summary of findings from coordination with TA1, other TA2 tracks, and Government Team at in-person TIM	$200,000
6	Design Revision 2	15	• Revision of component design based on Government feedback and delivery of revised documentation • Presentation delivered at virtual TIM that updates Government Team on detailed technical R&D progress • Presentation delivered at virtual TIM that updates a program-wide audience on the necessary component details for architecture development	$200,000
7	Final Interface Control Document	18	• Final interface control document • Revision of component design based on Government feedback and delivery of revised documentation • Presentation delivered at in-person TIM that updates Government Team on detailed technical R&D progress • Presentation delivered at in-person TIM that updates a program-wide audience on the necessary component details for architecture development • Summary of findings from coordination with TA1, other TA2 tracks, and Government Team at in-person TIM	$300,000
8	Design Revision 3	21	• Revision of component design based on Government feedback and delivery of revised documentation • Presentation delivered at virtual TIM that updates Government Team on detailed technical R&D progress • Presentation delivered at virtual TIM that updates a program-wide audience on the necessary component details for architecture development	$200,000

** Payments listed for each milestone are not-to-exceed amounts.*

TA2: QSB Milestones

Milestone		Month	Exit Criteria/Deliverable	Payment*
9	Full-Function Testing	24	• Experimental demonstration of full component functionality • Optimized interconnect designs, and detailed analysis of interconnect performance and future outlook • Delivery of functional component to Government team • Revision of component design based on Government feedback and delivery of revised documentation • Presentation delivered at in-person TIM that updates Government Team on detailed technical R&D progress • Presentation delivered at in-person TIM that updates a program-wide audience on the necessary component details for architecture development • Prototype Delivery: physical proof-of-concept device. • Final Report (End of Phase Report)	$300,000

** Payments listed for each milestone are not-to-exceed amounts.*

Government Team Milestones

Government Furnished Information		Month	Deliverable
1	Parameters	1	Representative parameters of qubit hardware, error correction codes, and interface parameters to guide TA1 and TA2 development
2	TA1 Optimization Function	1	Formula to convert resources calculated by TA1 compiler into efficiency figure of merit
3	Small Benchmark Circuits	3	Representative small (<10 logical qubits) benchmark circuits to run TA1 framework
4	Large Benchmark Circuit	12	Representative large (>1,000 logical qubits) benchmark circuit to run TA1 framework
5	Architectural Specifications	TBD	System co-design information will be provided up to quarterly to guide TA1 and TA2 redesigns

Represents milestones provided to performers for HARQ

9-month Scale-Up Period (optional)

- After month 12 of Phase I, DARPA may authorize, at its sole discretion, a 9-month Scale-Up Period **through a modification to the Agreement**

- During the 9-month Scale-Up Period, performers are expected to **integrate their capabilities through formal agreements between each other and pursue hardware/software co-design work** towards an end-to-end interconnect demonstration, for a potential Expanded Program Follow-On Tasking (EPFT)

- DARPA requests that **proposers capable of the Scale-Up Task** include the **optional** 9-month Scale-Up Period in their proposal to facilitate a smooth transition to the EPFT

Milestone		Month	Exit Criteria/Deliverable	Payment*
1	Team Integration	3	• Execute subcontracting arrangements and establish an optimized team composition required for end-to-end interconnect demonstration concepts	$150,000
2	CUI Compliance Readiness	6	• Establish CUI-compliant systems and processes	$200,000
3	EPFT Plan	9	• Develop a test plan for an end-to-end interconnect demonstration • Develop a Task Description Document and Cost Proposal for an end-to-end interconnect demonstration • Develop an initial commercialization plan for HARQ technology	$300,000

** Payments listed for each milestone are not-to-exceed amounts.*

Expanded Program Follow-On Tasking (EPFT)

- Separate from the 24-month Phase I and 9-month Scale-Up Period, DARPA may, at its sole discretion, negotiate and incorporate EPFT with a period of performance ranging from 12–24 months

- EPFT may include significantly expanded scope, integration of new tasks, or broader implementation of capabilities demonstrated under the Base Effort.

- **EPFT will only be incorporated through mutual agreement and a modification to the Agreement** establishing its scope, milestones, and funding. The decision to incorporate EPFT will be based on the technical results of Phase I, Scale-Up Period, mission priorities, and availability of funds.

Acquisition Strategy

- **Abstracts with virtual Q&A meeting**
  - **Abstracts are required to submit a full proposal**
  - Virtual 30-minute Q&A meetings will be held from **September 4–17, 2025**
  - During the Q&A meeting, the Government will ask the proposers clarifying questions about their abstract
- **Abstract Response Letters**
  - DARPA will respond to all abstracts with a statement as to whether DARPA:
    - (1) Recommends the proposer submit a full proposal or,
    - (2) Does not recommend the proposer submit a full proposal with a rationale for this decision
    - Regardless of DARPA's response to an abstract, proposers may submit a full proposal
- **Notification of Intent to Propose**
  - **DARPA requests that proposers provide a notification of their intent to propose** no later than **October 1, 2025**
  - Submit your notification by email to HARQ@darpa.mil
- **Proposals with virtual Oral Presentation**
  - Proposals and Oral Presentation slides are due no later than **October 14, 2025**
  - Virtual 45-minute Oral Presentations with 45-minute Q&A sessions will be held from **October 22 – November 4, 2025**
- **Other Transaction (OT) Agreement Negotiation**
  - After the Oral Presentations, the Government will select proposers to enter negotiations for an OT for Prototype agreement under 10 U.S.C. § 4022

Associate Performer Agreement (APA) Expectation

- Coordination between TA1 and TA2 is critical for the HARQ program's success
- All performers will be required to sign APAs with all other performers within 30 days of OT award

DARPA-PS 25-31

ATTACHMENT K

ASSOCIATE PERFORMER AGREEMENTS

It is recognized that the success of the Heterogeneous Architectures for Quantum (HARQ) research effort depends in part upon the open exchange of information between the various performers involved in the effort. Therefore, any resultant award instrument stemming from this Program Solicitation will include a term/condition classifying performers as "Associate Performers" and requiring them to enter into an Associate Performer Agreement with all other HARQ performers, with each performer then assuming the responsibilities of an Associate Performer. The paragraphs below outline the general verbiage pertaining to Associate Performer Agreements proposers can expect in a resultant HARQ award.

Important Dates

Dates/Time: All Times are Eastern Time Zone (ET)

- **Abstract Due Date:** August 28, 2025, at 1:00 p.m.
- **Abstract Virtual Q&A Dates:** September 4–17, 2025
- **Notification of Intent to Propose:** October 1, 2025, at 5:00 p.m.
- **Question Submittal Closed:** October 1, 2025, at 5:00 p.m.
- **Proposal Due Date:** October 14, 2025, at 4:00 p.m.
- **Virtual Oral Presentation Dates:** October 22 – November 4, 2025
- **Estimated Period of Performance Start:** February 1, 2026

Questions: HARQ@darpa.mil

Contracting Overview

Nestor GomezBello, Contracting Officer
DARPA Contracts Management Office

Proposers Day Disclaimer

The purpose of Proposers Day is to make general information available to potential proposers to clarify program goals/objectives and proposal preparation instructions.

However:

- **The information/instructions in the PS take precedence over any other source of information to include proposers day.**
- **Proposals will be evaluated in accordance with the instructions provided in the PS**
- **Any response provided by the Government in the Q&A session that is different than what is provided in the PS will be made formal by an amendment to the PS**
- **<u>Only a duly authorized Contracting Officer may obligate the Government</u>**

HARQ PS Overview

- **The HARQ PS allows for a variety of technical solutions:**
  – The PS defines the problem set, the proposer defines the solution

- **Types of Instruments that may be awarded:**
  - Phase 1 TA1 and TA2: Other Transaction for Prototype Agreements under 10 U.S.C. 4022

- **DARPA Scientific Review Process**
  – Proposals are evaluated on individual merit and relevance as it relates to the stated research goals/objectives rather than against one another
  – Selections will be made to proposers whose proposals are determined to be most advantageous to the Government, all factors considered, including potential contributions to research program and availability of funding
  – Evaluation Criteria for each TA are in Section II of the PS

- **Government may select for negotiation all, some, one, or none of the proposals received**

HARQ Program Structure

- **HARQ is a single-phase 24-months program**;
- Phase I will be executed in two separate but aligned technical areas (TA1 and TA2)

- **Technical Area 1:**
  - Phase 1 (Base) – 24-month period of performance
  - Other Transaction for Prototype
  - Include the deliverable of one compiler prototype

- **Technical Area 2:**
  - Phase 1 (Base) – 24-month period of performance
  - Other Transaction for Prototype
  - Include the deliverable of one component prototype

- A single proposal shall not address both technical areas. However, proposers may submit multiple separate proposals, each addressing a single Technical Area
- Both TAs will run concurrently during Phase I.
- Associate Contractor Agreements (ACAs) among all HARQ performers must be executed within 30-days of award.

Phase 1 has a potential Scale-Up Period (9-months).

After the Scale-Up Period, there is potential for Expanded Program Follow-On Tasking (EPFT) i.e. Additional Task. (estimated 12–24-months)

- Team Integration is required
- EPFT proposal is a deliverable of the Scale-Up Period
- Modification to the Other Transaction for Prototype Award

Proposer Eligibility Considerations

- Foreign participants/resources may participate to the extent allowed by applicable Security Regulations, Export Control Laws, Non-Disclosure Agreements, and other governing statutes applicable under the circumstances.

- To ensure fair competition across the ecosystem, **UARCs and FFRDCs (including National Labs) are prohibited from proposing** in any capacity, whether as a Prime, Subcontractor, or Consultant.

- UARCs and FFRDCs interested in participating in HARQ should contact the Agency Point of Contact (POC) listed in the Overview section of the solicitation prior to the proposal (or abstract) due date to discuss **potential participation as part of the Government team.**
  - Please note that this paragraph supersedes the *"Special Eligibility Considerations for Federally Funded Research and Development Centers (FFRDCs) and Government Entities"* section found at Proposer Instructions and General Terms and Conditions.

- Organizational Conflicts of Interest (OCI):
  - Cannot simultaneously serve in advisory (i.e., SETA, IV&V, etc.) and performer role
  - Identify any conflicts
  - If any are identified, a mitigation plan must be included

Proposer Eligibility Considerations

At the time of proposal submission:

- Proposers must have a Commercial and Government Entity (CAGE) code and a Unique Entity ID (UEI) registered in the System for Award Management (SAM) at SAM.gov.

- Foreign Proposer must have a valid US Bank account information in their SAM registration. This will avoid payment issues

At the time of contract award:

- Proposers must be registered in the prescribed Government invoicing system (Wide Area Work Flow (WAWF): https://wawf.eb.mil/xhtml/unauth/registration/notice.xhtml).

Proposer Eligibility Considerations

- **Abstract are required to then submit a proposal**

- The Government will reply by letter with one of the two below resposnses:
  - Encourage Full Proposal, and will provide feedback
  - Discourage Full Proposal, and will provide rationale

- Regardless of DARPA's response to an abstract, proposers may submit a full proposal
  - DARPA will review all full proposals submitted without regard to abstract recommendation/feedback

- Foreign Proposer must have a valid US Bank account information in their SAM registration. This will avoid payment issues

At the time of contract award:

- Proposers must be registered in the prescribed Government invoicing system (Wide Area Work Flow (WAWF): https://wawf.eb.mil/xhtml/unauth/registration/notice.xhtml).

DARPA Fundamental Research Risk-Based Security Review Process

- Effective June 30, 2025, the DARPA Fundamental Research Risk-Based Security Review (FRRBS) will be conducted on all fundamental research awards executed through non-FAR-based instruments.

- FRRBS is an adaptive risk management security program designed to help protect the critical technology and performer intellectual property associated with DARPA's research projects by identifying the possible vectors of undue foreign influence. The DARPA team will create risk assessments of all proposed Senior/Key Personnel selected for negotiation of a fundamental research award. The DARPA risk assessment process will be conducted separately from the DARPA scientific review process and adjudicated prior to final award.

- For any proposal where fundamental research is included, proposers must submit the (1) Common Form for Biographical Sketch, and (2) Common Form for Current and Pending (Other) Support Information form for all covered individuals, in addition to the volumes and required attachments specified elsewhere in this Program Announcement. Both forms are available via the NSF website **-** **NSPM-33 Implementation Guidance - Division of Institution and Award Support (BFA/DIAS) | NSF - National Science Foundation** Proposers must review the DARPA Fundamental Research Risk-Based Security Review Process detailed at **Proposer Instructions: Other Transactions | DARPA**

Intellectual Property (Data Rights)

- For HARQ – Government will require **Government Purpose Rights (GPR)** to intellectual property (IP) developed under the program
- Identify any items that would prohibit GPR
- Performers will provide regular updates to the government regarding:
  - Any changes to the overall IP posture that specifically deviate from GPR,
  - Additions to previously asserted or defined rights due to technology development,
  - Anticipated challenges to GPR.

This information will help inform the Expanded Program Follow-On Tasking (EPFT) and any subsequent IP negotiations.

- Evaluation Criterion, Potential Contribution & Relevance to DARPA Mission, includes the following consideration:
  - ***The proposed intellectual property restrictions (if any) will not significantly impact the government's ability to transition the technology*.**

Other Considerations

- HARQ is subject to the MTO CUI Guide (see Attachment L)

- HARQ is subject to an Associate Contractor Agreement (ACA).
  - Regardless of TA, all HARQ performers will enter into ACAs within 30 days after Award

- Proposal submissions are anticipated to be unclassified or CUI.
  - However, should a proposer wish to submit classified information, an unclassified email must be sent to HARQ@darpa.mil notifying the MTO Program Security Officer.

- Fundamental Research:
  - If you believe an effort includes fundamental research, it is the **proposer's responsibility** to (1) identify the work; and (2) explain why it qualifies as fundamental; and (3) intended results of the research.
  - The government shall have the sole discretion to determine fundamental research designation
  - Given the nature of the program, both fundamental and non-fundamental research **may** prescribe publication requirements and other restrictions, as appropriate

Tips for a compliant proposal

- **Submit the proposal on time!**
  - Proposal due date and PS closing date are the same – do not be late!
- **Submit all required Attachments!**
  - **READ** instructions contained within each Attachment!
  - All proposals must include a detailed list of key, observable Tasks in the Milestone Plan
  - All proposals must include a list of additional deliverables (if proposing in addition to PS requested)
- **Submit all proposal Volumes**
- **Submit all Cost/Price supporting documentation**
  - All proposals must include FPRA, FPRR, PBR, Suppliers Quotes, Paystubs, Basis Of Estimate, etc.
- **Submit within the page limitations described in the PS!**
  - Pages beyond the limit will not be reviewed

Communication

- **Prior to Receipt of Proposals (Solicitation Phase): No restrictions, however Gov't (PM/PCO) shall not dictate solutions or transfer technology**
  - Typically handled through the FAQ, but see PS exceptions

- **After Receipt of Proposals/Prior to Selections (Scientific Review Phase): Limited to Contracting Officer or PS Coordinator (with approval) to address clarifications requested by the review team**
  - Proposal cannot be changed in response to clarification requests

- **After Selection/Prior to Award (Negotiation Phase): Negotiations are conducted by the Contracting/Agreements Officer**
  - PM and/or COR typically tasked with finalizing the SOW (with PI)
  - PM and/or COR typically involved in any technical discussions (i.e., partial selection discussions)
  - Pre-award costs will not be reimbursed unless a pre-award cost agreement is negotiated prior to award

- **Informal Feedback Sessions (Post Selection): May be requested/provided once the selection(s) are made**
  - If made on a timely basis (~2 wks. after letter), all requests will be accepted

Introduction to DARPAConnect

Sana Hoda Sood, Applied Research Institute

DARPA

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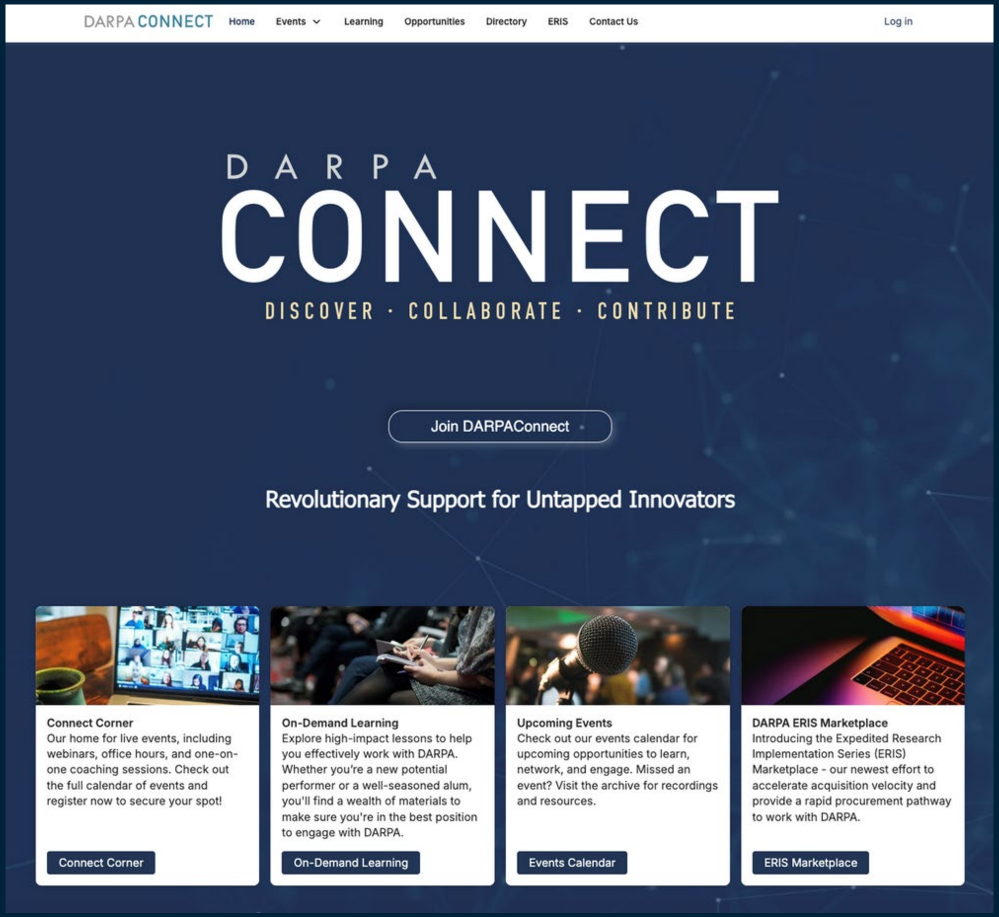

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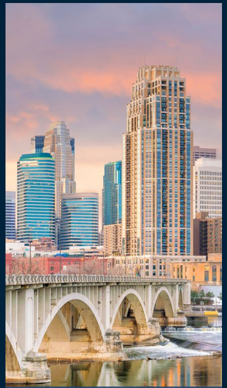
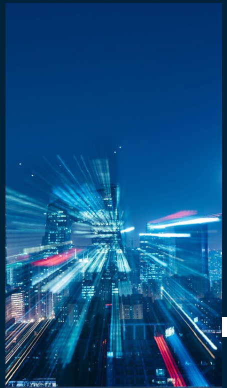
- Understanding DARPA Security Resources
- Preparing Your DARPA Proposal
- Tying It All Together: Strategies for Success
- Opportunities for Networking

2025 DARPAConnect Pop-Up Locations



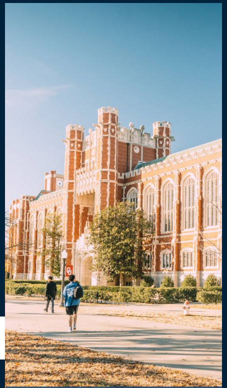
Minneapolis, MN
February 2025

Huntsville, AL
May 2025



Virtual
July 2025

Bozeman, MT
September 2025



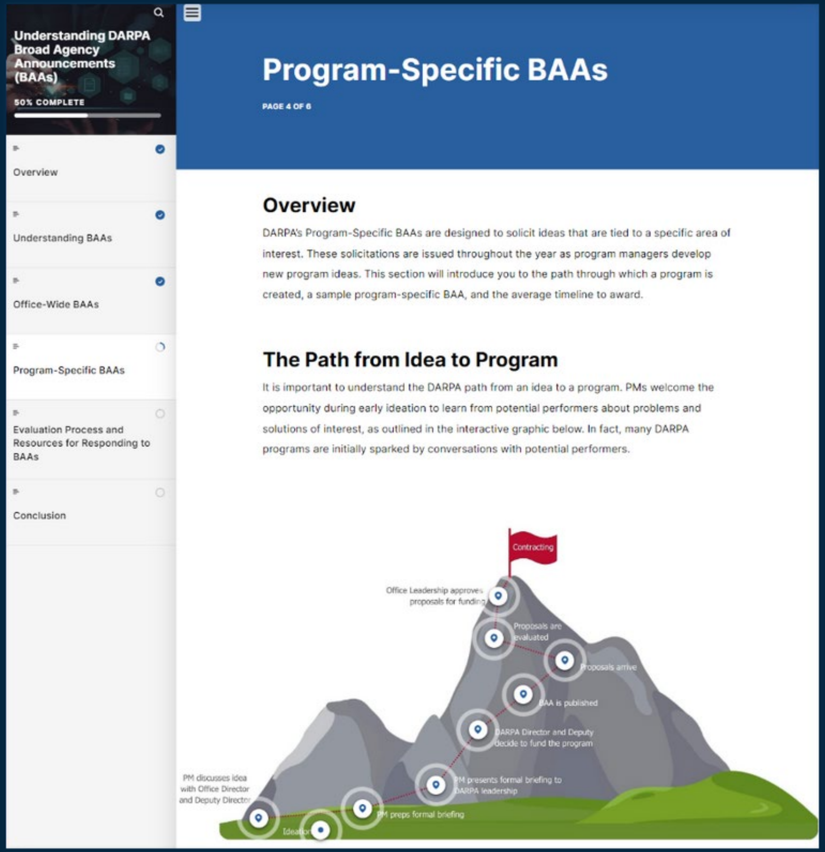
Seattle, WA
November 2025

Distribution Statement "A" (Approved for Public Release, Distribution Unlimited)

DARPAConnect Curriculum

Lessons Include:

- DARPA 101: Introduction to DARPA
- DARPA Advanced Research Concepts Explained
- DARPA Award Vehicles and Solicitations
- DARPA SBIR/STTR Small Business Programs
- Introduction to DARPA Security
- Making the Most of a DARPA Proposers Day
- Opportunities to Work with DARPA
- Teaming Basics: Building an Effective Team
- The Heilmeier Catechism
- Tips for DARPA Proposal Success
- Understanding DARPA Broad Agency Announcements (BAAs)
- Understanding Intellectual Property
- Working with DARPA: Global Participation and Engagements
- Understanding Facilities Clearances
- Innovating Acquisition: Introduction to DARPA Other Transactions



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Frame your ideas using DARPA's Heilmeier Catechism

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Thank You.

For more information or to request assistance, please visit:
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Welcome

Proposers Day Agenda

Start (ET)	Topic / Speaker
10:30	**WEBINAR CHECK-IN**
11:00	**Welcome** *Neal Oza/MTO Technical SETA*
11:05	**Introduction to MTO** *Whitney Mason, DARPA/MTO Office Director*
11:10	**Program Overview** *Justin Cohen, DARPA/MTO Program Manager*
12:10	**Contracting Overview** *Nestor GomezBello, DARPA/CMO Contracting Officer*
12:25	**Introduction to DARPAConnect** *Sana Hoda Sood, Applied Research Institute*
12:30	**BREAK**
13:30	**Question & Answer Session** *Justin Cohen, DARPA/MTO Program Manager*
15:00	**ADJOURN**

Question & Answer Session

Justin Cohen, Program Manager
DARPA Microsystems Technology Office

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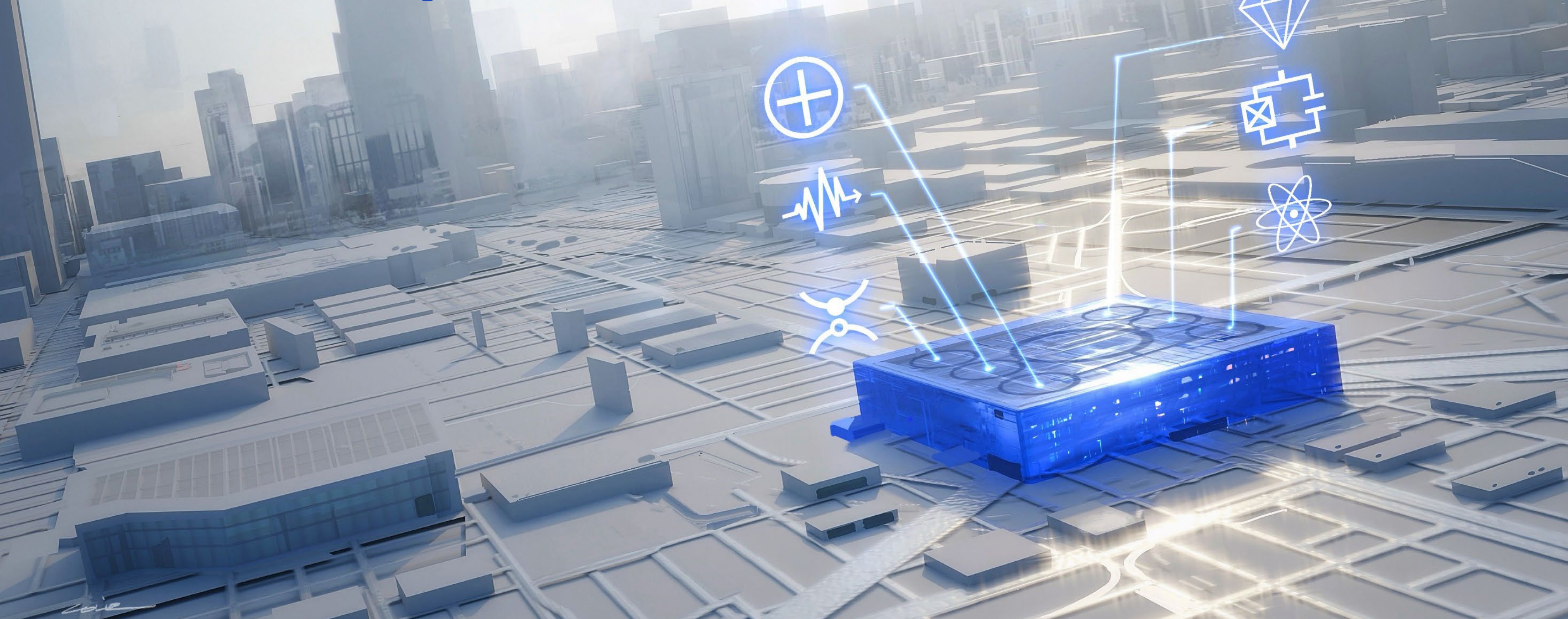
  - Maria Gorgone
  - Clement Wong
  - Nathan O’Malley
  - Santanu Basu

- This audience!

DARPA

HARQ
Heterogeneous Architectures for Quantum



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