General

1. What is the available budget for the UWBGS effort? Often this is publicized in the BAA but has not for UWBGS
    - The available budget will not be published.

2. Is DARPA contemplating a "substantial" investment behind UWBGS just like WBGS or will it be more akin to DREAM / THREADS?
    - UWBGS is analogous to WBGS program, which had 3 phases. This BAA is analogous to Phase 1 of WBGS program, which focuses on foundational materials. Per page 29 of the BAA, proposers should include potential applications for UWBG materials and devices that would motivate program expansion as well as potential technology transition/insertion opportunities.

3. In Section G (pg. 16) of the BAA it says “No Government Furnished Equipment.” Is capital equipment allowed on budgets in the UWBGS program?
    - It is expected that proposers already have capital equipment that is needed to exercise their proposed approach. If there is unique equipment or an accessory that is necessary, that may be included along with substantial justification/rationale, which will be evaluated in cost realism.

4. Are FFRDCs and national labs allowed to work as prime contractors or subcontractors on a proposing team?
    - Yes, FFRDCs and national labs are not prohibited from working as prime contractors or subcontractors, however they must clarify in their proposal how they will manage OCIs and other requirements indicated in the BAA (pages 23 – 25)

5. Is there any preference for or against a university-only program?
    - No preference, as long as the team and proposed approach can meet the requirements of the BAA.

6. If awarded, would it be possible to use NRL capabilities through collaborations regularly, or is it only available for testing the deliverables?
    - NRL is the IV&V team, which involves independent testing of deliverables. Performers are expected to coordinate with the IV&V team to define appropriate material, electrical contact, and diode test structures. Per page 14 of the BAA, proposers should provide detailed information in their proposal on how they plan to develop and characterize the substrates, device layers, junctions, test structures, and test diodes under this program.

7. Can one organization submit two technical area 1 (TA1) (or technical area 2 (TA2)) proposals?
    - Yes, one organization can submit two TA1 (or TA2) proposals. The proposals are expected to be completely independent in their approach for solving the technical challenges.

8. Can alternative metrics and milestones be proposed if justified?

- Yes, proposer defined metrics and milestones can also be proposed, and must be justified. However, all DARPA metrics and milestones for a given TA (BAA Table 1 and 2 on pages 12 and 13) must be met.

9. What publication clearance is needed form DARPA before publishing papers in this program?
    - All material for publication/public release will need to complete DISTAR review/approval.

10. Shall we propose for Phase I only for this call now?
    - No, propose for both phases.

11. Page 5 of the BAA lists Cooperative Agreement, Procurement Contract or Other Transaction as types of instruments that will be awarded. Would Grants also be considered an awardable type of instrument?
    - No.

12. Is modeling recommended for material properties?
    - Physics-based modeling that provides insights into how material should be manipulated/optimized to reduce defect density, increase doping efficiency, and optimize junctions and contacts is within scope.

13. Can one vendor or subcontractor participate on multiple proposals?
    - Yes

14. How should a service provider navigate requests to participate on multiple teams?
    - DARPA cannot provide any guidance, but advises organizations to decide where their efforts are most useful.

15. Is Ga_2O_3 out of scope due to thermal conductivity limitation?
    - Materials must meet thermal conductivity constraints listed in Tables 1 and 2 of BAA (pages 12 and 13).

16. Should we emphasize characterizing defects in material?
    - TA1 includes a defect density metric. For TA2, characterizing defects is also important because of its strong role in doping efficiency. TA2 also specifies a junction defect density.

TA1

17. Does thermal conductivity greater than 300 W/m-K refer to the average/composite/effective thermal conductivity for instance in a bonded diode structure?
    - Per BAA Table 1 on page 12, the thermal conductivity of 300 W/m-K is applicable to the UWBG substrates (TA1). Per BAA Table 2 on page 13, TA2 doped layers, heterojunctions and test structures must have a minimum thermal conductivity of 50 W/m-K.

18. Is polycrystalline diamond substrate with reduced defects and improved device quality electrical properties of any interest to this program?
    - To create devices layers, for example to grow device quality epitaxial layers, it is anticipated that large area single crystal substrates are required. Surface quality is also important for fabrication of devices, and it is not anticipated that this can be achieved with polycrystalline substrates.

19. Other than the usual UWBGS (such as AlN, BN, Diamond), will DARPA be interested in UWBGS oxides as a possible material platform?
    - The breadth of UWBG semiconductors is broad. This program focuses on substrate materials with high thermal conductivity. Any UWBGS material that can achieve high thermal conductivity and doping targets outlined in the BAA (metrics tables on pages 12 and 13) may be considered as a candidate material. Per page 28 of the BAA, proposers are expected to provide the rationale and evidence that their proposed UWBGS material meets all of the BAA metrics for a given TA.

20. Could you comment on the point defect density goal for substrates? The impact on thermal conductivity could be affected by point defect density but that is listed as a separate requirement. Is the concern about conductivity and deep levels for RF applications? Would it be acceptable to use epi and device results to evaluate efficacy for application?
    - As indicated on page 28 in the BAA, substrates must simultaneously meet all of the metrics and constraints for TA1.

21. Will you consider UWBG alloys (for instance, high Al content AlGaN) to be responsive?
    - Yes, as long as thermal conductivity constraints listed in the BAA for TA1 (page 12) and TA2 (page 13) are met.

22. Will contact study for nanowire structures be of your interest or only for thin-film structure?
    - Nanowire structures are not in the spirit of the BAA.

23. There is a thickness requirement for substrates in the BAA. Does it mean developing templates (if it meets all other specs) is not considered?
    - Substrates or templates must be 0.5 mm nominal thickness that is listed in Table 1 of the BAA (page 12). The program is looking for free standing substrates that would need to be separated from templates or other seed layers used to create substrates.

24. Would heterogeneous integration for thermal reasons be responsive? For example, using a Ga_2O_3 epi layer on a SiC substrate.
    - Heterogeneous integration for thermal reasons only is not within the spirit of this BAA.

25. As a general question regarding TC1: Creation of large area device quality UWBG substrates, what TRL is sought in this program?
    - There is no TRL requirement. Substrates are required to meet metrics in BAA Table 1 (page 12).

26. Is development of process to wafer these materials within scope?
    - Yes, per Section B of BAA (page 9).

TA2

27. The BAA states that meeting TA2 metrics likely requires substrates that meet TA1 metrics. How do TA2 performers incorporate TA1 approaches when TA2 proposals must stand alone to be successful? Do we assume a cost placeholder for a future material? Or can we assume it will be provided as GFE?
    - No, TA2 Phase 2 substrates will not be provided as GFE. Proposers should clarify in their proposals how they will acquire their substrates, what the quality of those substrates will be relative to Phase I program goals, what quantity of substrates will be needed, and how much the substrates will cost to successfully address the goals of Phase II program effort. Per footnote 9 of BAA Table 2 on page 13, the device electrical measurements at the end of Phase 2 must occur across a minimum of 50 mm diameter wafer. For TA2, it is expected that the proposers will provide evidence that their process approach is scalable to 100 mm.

28. Is there any expectation to demonstrate TA2 goals on 100 mm substrates? Or a maximum of 50 mm wafer is acceptable.
    - BAA Table 2 on page 13 specifies that the TA2 electrical measurements must be measured over a minimum of 50 mm diameter wafer.

29. Is a TA2 approach that can meet metrics by using commercially available substrates an approach that will be responsive to the BAA?
    - Yes, if this approach can be demonstrated on other substrate types and still meet all of the TA2 metrics.

30. Does DARPA allow sourcing of commercial substrates from foreign countries?
    Yes.

31. Can you elaborate on the normalized doping efficiency figure of merit? If the theoretical doping efficiency is 1%, will the program goal be met if the performer reaches 90% of 1%?
    - Yes, however, per BAA Section B (page 9), it is anticipated that the doping efficiency will be much greater than 1%. Proposers should provide a detailed analysis of the doping efficiency for their proposed materials. Proposers should provide innovative approaches to dramatically increase doping efficiency.

32. Are doping efficiencies at elevated/operational temperatures relevant to TA2 requirements?
    - Doping efficiency at elevated/operational temperatures are of interest.

33. Is doping by high temperature implantation acceptable?
    - Yes.

34. Is DARPA interested in understanding how implantation impacts mobility?
    - Yes, although the goal is to achieve efficient doping.

35. Many possible diode test structures are mentioned, such as Schottky diodes and PiN diodes. The TA2 metrics refer to doping control and contacts to both p- and n-type semiconductors. Does DARPA therefore expect PiN diodes that integrate both n- and p- layers into the same device? Or are unipolar Schottky diodes acceptable? If Schottky diodes are acceptable as final test structures, would a proposal have to tackle both n- and p-type Schottky diodes?
    - The diodes are test vehicles to demonstrate improvement and n- and p-type doping. While PN or PIN is one way to do this, unipolar diodes are acceptable. In this case, proposers are expected to demonstrate both n- and p-type unipolar diodes.

36. Would materials development for lateral device architecture be of interest?
    - The test device is proposer defined and is a vehicle to measure material quality, doping efficiency, and electrical contacts. Both vertical and lateral devices are within scope as long as they meet the TA2 metrics.

37. Can you comment on DARPA's expectations for device area scaling in TA2, in order to hit the cut-off frequency target? Drift region design? Scaled for high frequency or high voltage?
    - The proposer must define a diode test structure that meets the metrics in Table 2 (page 13) of the BAA.

38. Will we need growth capabilities for TA2?
    - The need for growth capabilities in TA2 depends on proposer approach and material system.

39. Does this program encourage heterogeneous integration of different materials?
    - Yes, the BAA on page 10 identifies this as a potential approach for creating p-n junctions.

40. Will bonding with narrow band gap materials considered?
    - Yes, provided that this approach will meet the Table 2 BAA metrics on page 13, including the breakdown field listed in the footnotes.

41. Can heterogeneous junctions be used for surface modification?
    - Per the BAA on page 10, heterogeneous junctions for p-n junctions or modifying metal/semiconductor interface are within scope.

42. For the metal contact, is grading to a lower bandgap acceptable?
    - Intermediate or grading layers are a path to lower contact resistance and within the scope of the BAA (page 10).

43. For heterogeneous integration approach, should there be a path to 100 mm?
    - Yes