Topic: Harnessing Entanglement Distribution

Background: Along with superposition, entanglement is an essential feature of quantum information science in both experimental demonstrations (e.g. from the first fundamental multi-qubit logic gate [1] to current quantum computing implementations [2], non-local correlations in many-body systems [3], and a multi-node quantum network [4]) and theoretical proposals (e.g. quantum sensing networks [5], quantum illumination [6], and clock synchronization [7]). Utilization of the power afforded by entanglement is mostly focused on tailored applications in metrology, communication, cryptography, computing, clock synchronization, and imaging. Recently, distributing entanglement is presented as a means to scale up systems or to connect nodes with similar functionality, for example arrays of sensors, computation devices, or communications relays.

Objective: This call seeks to discover any advantages over classical system analogs (if one exists), either in functionality or in performance, as well as a quantitative understanding of the benefits and limitations of interconnected quantum devices or nodes that function together to achieve overarching goals. Proposals should describe new concepts and processes that inherently rely on distributing quantum information and entanglement across the nodes in a realistic environment. This call seeks basic research ideas that challenge conventional assumptions and explore new ways to approach and leverage distributed entanglement. In particular, distributing quantum information between nodes that do not necessarily share the same characteristics is envisioned. Any proposed work must include theory and analysis. Proposals may include an experimental demonstration component on either a currently available system or a near-ready system on a laboratory scale that does not include quantum transduction. Scaling up a system alone is not in scope.

Anticipated Resources: This opportunity is in scope of the Quantum Information Science (QIS) program as outlined in Open BAA FA9550-21-S-0001 [8] and proposals will be evaluated in accordance with the evaluation factors in the BAA. It is anticipated that two awards will be granted under this topic, with no more than $450k over two years, per award. An optional third year is contingent on funding availability and performance.

References:
[1] Phys. Rev. Lett. **75**, 4717 (1995)
[2] https://arxiv.org/abs/2102.11521
[3] Science **364**, 256 (2019)
[4] Science **372**, 259 (2021)
[5] Phys Rev. A **97**, 042337 (2018)
[6] Science **321**, 1463 (2008)
[7] Nature Phys. **10**, 582 (2014)
[8] https://www.grants.gov/web/grants/search-grants.html?keywords=FA9550-21-S-0001