April 15th, 2024

To whom it may concern,

This letter recommends Dr. David Bakken, whom I've known for the past three decades in various capacities as a researcher in the field of distributed systems and a program manager at the Defense Advanced Research Projects Agency (DARPA). I am therefore quite familiar with Dr. Bakken's talents, accomplishments, and dedication. After giving a brief overview of my background, this letter of recommendation outlines the work that Dr. Bakken is doing and describes why he has the aptitude, skills, and dedication to continue to be a leading researcher in his field.

I am the Cornelius Vanderbilt Professor of Engineering (Computer Science), the Associate Chair of the Computer Science Department, and a Senior Research at the Institute for Software Integrated Systems, all at Vanderbilt University. During the past three decades, I have published 10+ books and 700+ technical papers covering a wide range of software-related topics, including patterns, optimization techniques, and empirical analyses of object-oriented frameworks and domain-specific modeling environments that facilitate the development of distributed real-time and embedded (DRE) middleware and intelligent mobile cloud computing applications running over data networks and embedded system interconnects. I was recently nominated by President Biden and confirmed by the United States Senate to serve as the Director of Operational Test and Evaluation for the United States Department of Defense and was sworn into this position by the Deputy Secretary of Defense Dr. Kathleen Hicks on April 8th, 2024.

During my sabbatical in 2010-2011, I served as the Chief Technology Officer for the Software Engineering Institute (SEI) at Carnegie Mellon University, where I was responsible for directing the technical vision and strategic R&D investments for the SEI. From 2000 to 2003 I served as a Deputy Office Director and a Program Manager at DARPA, a position that Dr. Bakken's suggestion to the DARPA Information Technology Office Director Dr. David Tennehouse enabled, where I led the national research and development effort on middleware for distributed real-time and embedded (DRE) systems. During that time, I also cochaired the Software Design and Productivity (SDP) Coordinating Group of the U.S. government's multi-agency Networking and Information Technology Research and Development (NITRD) Program, which helped to formulate the national multi-agency software research agenda. From 2018 to 2022 I served as the Associate Provost for Research and the Co-Director of the Data Science Institute at Vanderbilt University.

I first met Dr. Bakken in 1995, when he was working at the prestigious research lab BBN in the Boston Area. He had identified my ACE middleware platform, and The ACE ORB (TAO) real-time object request broker middleware on top of it, for use in DARPA contracts with their Quality Objects (QuO) middleware. I was at Washington University in St. Louis (WUSTL) then, where I was conducting research on middleware for DRE systems.

The Distributed Systems Department (DSD) that he was in at BBN has done groundbreaking, applied research on middleware since the late 1970s. BBN built the first internet, the AR-

PANET, in 1969, and continued to work with networks and network applications on government and commercial contracts. DSD's research is applied, and always involves a significant solid prototype and demonstrations; in other words, it is the opposite of theory-only research that only produced throwaway prototypes that nobody could ever possibly use, which is what probably 80% or even 90% of DS researchers do. They get a lot more papers published that way.

Dave's other co-leads on the QuO project were Dr. Richard (Rick) Schantz and Dr. John Zinky. Rick was Dave's mentor, and I consider him to be the "Father of Middleware". John is a networking researcher, who in 1982 was in charge of 100% of the routing on the ARPANET. (He left BBN a few years ago, and now is Chief Performance Analyst at Akami, a content-distribution platform that predated cloud computing). QuO could never have happened without all three of their skillsets.

Dr. Bakken was the academic type among this "QuO Trinity". He made sure to utilize the latest in the state of the art and was their academic liaison. In this role, he identified leading researchers at universities whose research could fit nicely into BBN's vision for QuO. In this capacity, he recruited leading researchers that provided high value-added to the QuO framework, including from Cornell, University of Illinois at Urbana-Champaign, Carnegie Melon University, Georgia Tech, and others. Dr. Bakken is very highly regarded by all of them. He after his five years at BBN, he could have gone to some of these as a professor, but he wanted to build up his beloved undergraduate institution, Washington State University.

QuO was very impressive and was very high value-added for distributed applications that must run over the wide area, especially where the network and computing environments can vary widely dynamically. QuO integrated subsystems do provide Quality of Service (QoS). At the time, QoS was considered to be network latency and jitter over a tightly controlled local area network. This focus was important, but the military needed much more, as did commercial applications as the Internet started to catch on in the mid-1990s.

QuO was prototyped with 3 different QoS subsystems: Availability (which Dave led, using group communication and replication), Bandwidth "Reservation" (lead by Zinky), and cyber-security; the latter was after I was involved with Dave and his part at BBN. In one demo for the NAVY, QuO integrated seven different organizations' QoS-related technologies, including monitoring and management. That scale of integration is virtually unheard of, but it was what QuO was designed for. I do not have privy to the budget details, but QuO seemed to have 50-60 person-years of BBN labor invested in it by DARPA and others, and probably three times that in other organizations (WUSTL, Honeywell Labs, the aforementioned universities, etc.) It was evaluated by the Navy for use in their next-generation DD-21 program (which got side-tracked), flew in a Boeing experimental aircraft, etc. QuO was an integral part of the DARPA Quorum program, in fact, it comprised Quorum's integrating technology. Dave had a foundational role that directly led to all of that.

Dr. Bakken was a huge part in the DSD's growth. Before he joined BBN, they were well known but in a small circle of academic researchers and practitioners. Dr. Bakken was vexed by the fact that all their great work did not receive as much recognition as he felt it should, so he did what he could to help remedy that and was highly successful, from my vantage point.

In summary, the QuO project was very influential in shaping wide-are distributed systems, particularly for the military. Dave had a big hand in creating this. Their 1997 paper, *Architectural Support for Quality of Service for CORBA Objects*, is considered a seminal work in wide-area QoS – Dr. Bakken wrote 90% of it. When it came out, academics recognized there was something valuable there, but perhaps did not understand exactly what. However, practitioners were like "YOU FEEL MY PAIN!". It describes what QoS could, and should, be for wide-area networks (WANs).

I have kept in touch with Dr. Bakken since he left BBN for WSU in 1999, but, of course, not nearly as closely as when he was at BBN. His GridStat middleware-level data delivery system is extremely interesting. In particular, he has covered both resource extremes of wide-area data delivery QoS: GridStat is for very tightly controllable environments, and QuO for ones that vary (where QuO helps provide as much QoS as possible, and helps the application systematically adapt when it cannot provide as much as the application desires (think of a military environment with jamming, inadvertent interference, kinetic damage, etc.).

In summary, Dr. Bakken possesses a range of noteworthy research abilities and a long track-record of success. He is a dedicated scholar and engineer who understands how to scope out and successfully work on compelling research topics. From our interactions together over the past three decades, Dr. Bakken has consistently demonstrated his research aptitude, creativity, and dedication. I therefore recommend him for a senior consulting position in applied distributed computing.

Sincerely,

Douglas C. Schmidt

Professor of Computer Science
Cornelius Vanderbilt Professor of Computer Science
Associate Chair of Computer Science
Vanderbilt University, Nashville, Tennessee, 37203
d.schmidt@vanderbilt.edu
615 294 9573