Neural systems have two innate requirements: communication and computation. Any large-scale neuromorphic system will need to be optimized for both. This has led to the proposal of optoelectronic neuromorphic platforms that leverage the complementary properties of optics and electronics. Optical communication allows for direct connections between neurons which removes bottlenecks associated with network traffic. Electronic computation allows for complex synaptic and neuronal computation. Starting from the hypothesis that future large-scale neuromorphic systems will utilize integrated photonics and fiber optics for communication in conjunction with electronics for computation, we analyze and contrast two possible paths towards achieving this vision. The first is a semiconductor platform based on analog CMOS circuits and waveguide-integrated photodiodes. The second is a superconducting approach that utilizes Josephson Junctions and waveguide-integrated superconducting nanowire single photon detectors (SNSPDs). First, it is demonstrated that these two systems are capable of implementing nearly identical neuronal dynamics. With this established, the two platforms are compared from a variety of different viewpoints: power consumption, speed, area, potential for 3D integration, memory constraints, and cryogenic overhead. While both platforms still require significant technological innovations to become viable, we reach some early conclusions about their limits and identify key challenges to both technologies. For instance, if III-V integration achieves its long-sought goal of a practical integrated light-source at room-temperature, then there is likely to be only minimal advantage of utilizing superconducting optical links, even with communication at the single photon level. On the other hand, if one is willing to tolerate larger circuit footprints, superconducting neural circuits and memories appear to have significant power advantages over typical semiconductor implementations.