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Project Wing

Project Wing was a project of X that aims to rapidly deliver products across a city by using flying vehicles, similar to the Amazon Prime Air concept. At the time of the announcement on August 28, 2014, it had already been in development secretly at Google for about two years, with full-scale testing being carried out in Australia. The flying vehicles take off vertically, then rotate to a horizontal position for flying around. For delivery, it hovers and winches packages down to the ground. At the end of the tether is a small bundle of electronics which detects that the package has hit the ground, detaches from the delivery, and is pulled back up into the body of the vehicle. Dropping the cargo or landing were found to be unfeasible, as users compromised the safety [1].

In July 2018, the team graduated from X to become “Wing”, an independent Alphabet business. They are building a drone delivery system to improve the speed, cost and environmental impact of transporting goods, and an unmanned-traffic management platform to safely route drones through the skies. Wing will continue to collaborate closely with industry partners, regulators, and the broader aviation community to develop a common approach to safely and scalably managing drone traffic in the skies, so the potential of low-altitude airspace can be unlocked [2].

The team completed their first real-world deliveries in 2014 in rural Queensland, Australia where they successfully transported a first-aid kit, candy bars, dog treats, and water to farmers. Then in September 2016, the team delivered burritos to students at Virginia Tech in what was, at the time, the largest and longest drone delivery test on U.S. soil. Food is a great test case for drone delivery technology because it's fragile and temperature sensitive and therefore needs to be delivered quickly and carefully. The team is focused on refining how the delivery drones transport packages directly to suburban yards. Most recently, they've completed hundreds of deliveries to the yards of several homes in the Australian Capital Territory and Queanbeyan regions of Australia. The goal is to determine how to find the best route to a home and how to find a safe delivery spot in the yard. The Wing team is also learning how drone delivery might be useful in people's everyday lives by transporting meals, groceries, medicine, and even spare car parts in the event of a breakdown [3].

Project Loon

Billions of people around the world are still without internet access. Loon is a network of balloons traveling on the edge of space, delivering connectivity to people in unserved and underserved communities around the world. Delivering connectivity from balloons flying 20 km up in the stratosphere poses a unique set of engineering challenges. To expand connectivity to unserved and underserved areas around the world, Loon combines advancements in materials science, atmospheric modeling, machine learning, communications systems, and more. Loon has taken the most essential components of a cell tower and redesigned them to be light and durable enough to be carried by a balloon 20 km up, on the edge of space. Loon balloons are designed and manufactured to

endure the harsh conditions in the stratosphere, where winds can blow over 100 km/hr, and temperatures can drop as low as - 90° C. Loon is made from sheets of polyethylene, each tennis court-sized balloon is built to last for well over 100 days before landing back on Earth in a controlled descent. All the flight equipment is highly energy efficient and is powered by renewable energy. Solar panels power the system during the day while charging an onboard battery to allow for nighttime operations. Loon balloons travel approximately 20 km above the Earth's surface in the stratosphere, well above airplanes, wildlife, and weather events. Loon balloons can reach countries around the world from our launch sites. Predictive models of the winds and autonomous decision-making algorithms move each balloon up or down into a layer of wind blowing in the right direction, getting the balloon where it needs to go. The navigation system functions autonomously using our algorithms and software, with operators providing continuous human oversight. A group of Loon balloons creates a network that provides connectivity to people in a defined area in the same way a group of towers on the ground forms a terrestrial network. The difference is our "towers" are constantly moving with the winds. Our software is constantly learning to improve the choreography of the balloons, which improves the quality of the network. Entire network can function autonomously, efficiently routing connectivity across balloons and ground stations while taking into account balloon motion, obstructions, and weather events.

The balloon envelopes used in the project are made by Raven Aerostar, and are composed of polyethylene plastic about 0.076 mm (0.0030 in) thick. The balloons are superpressure balloons filled with helium, standing 15 m across and 12 m tall when fully inflated. They carry a custom air

pump system dubbed the "Croce" that pumps in or releases air to ballast the balloon and control its elevation. A small box weighing 10 kg containing each balloon's electronic equipment hangs underneath the inflated envelope. This box contains circuit boards that control the system, radio antennas and a Ubiquiti Networks 'Rocket M2' to communicate with other balloons and with Internet antennas on the ground, and batteries to store solar power so the balloons can operate during the night. Each balloon's electronics are powered by an array of solar panels that sit between the envelope and the hardware. In full sun, the panels produce 100 watts of power, which is sufficient to keep the unit running while also charging a battery for use at night. A parachute attached to the top of the envelope allows for a controlled descent and landing when a balloon is ready to be taken out of service. In the case of an unexpected failure, the parachute deploys automatically. When taken out of service, the balloon is guided to an easily reached location, and the helium is vented into the atmosphere [4].

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