Stratospheric Telecommunications Platform
HAPS

Representative Director & CTO, SoftBank Corp.
President and CEO, HAPSMobile Inc.

Junichi Miyakawa
We take a lot for granted in our daily lives
We take schools for granted
We take play for granted
We take hospitals for granted
We take access to information for granted
We take connecting with people for granted
We take all these things for granted
Some do not have what we take for granted
Some lack sufficient access to education
Some children work after school
Some have difficulty getting to hospitals
Some cannot freely express themselves
Some lack Internet access and connections to others
Half the world’s population has no Internet access

Number of people without Internet connectivity

3.7 billion

Source: Statista: Number of internet users worldwide from 2005 to 2018
We want to create an environment of equal access for all, regardless of birthplace
Bring the Internet to the whole world
What the Information Revolution brings through the Internet
What the Information Revolution brings through the Internet

Healthcare
What the Information Revolution brings through the Internet
What the Information Revolution brings through the Internet
The Information Revolution brings unlimited possibilities
Information Revolution — Happiness for everyone
Stratospheric Telecommunication Platform Business

HAPS MOBILE
HAPS
High Altitude Platform Station
Floating Base Station in the Stratosphere
Why the Stratosphere?
It all started with the 3.11 disaster
Deployed various mobile base stations

Large radio base station vehicle

Small radio base station vehicle

Portable base station vehicle
Aimed to provide uninterrupted communication in event of earthquakes or tsunamis

2011
Developed a tethered balloon radio relay system
Provides wide coverage, but cannot be used immediately after storms

Coverage area of approx. 10km

Inoperable in strong wind conditions
So we focused on the stratosphere
Stratosphere characteristic: steady air current
What is the stratosphere?

- **GEO area** (outer space) at approximately 36,000 km
- **LEO area** (outer atmosphere) at approximately 1,200 km
- **HAPS area** (stratosphere) at approximately 50 km
Providing mobile Internet from the sky by utilizing the stratosphere

Altitude: 20km
Uninterrupted communication in event of disaster made possible

Normal times

Time of disaster
Super-wide LTE/5G coverage

- 200km diameter covered with 1 HAPS
- Approx. 40 HAPS cover Japanese archipelago
High operability

Ability to fly for 6 months continuously

Stationary rotation possible at any coordinate
Mobile Internet can be provided for high-flying objects
Direct access possible with existing devices

HAPS

Satellite communication
Expand mobile coverage areas
Aviation certification process

- Type certificate
- Airworthiness certificate
- Spectrum
HAPS to use 2 spectrums
Service link standardization efforts

Until 2024

Spectrum identified in 2000

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>2.1GHz</th>
</tr>
</thead>
</table>

Beyond 2024 (To be identified in WRC-23)

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Service link</th>
</tr>
</thead>
<tbody>
<tr>
<td>450MHz - 2.6GHz</td>
<td>*WRC: World Radiocommunication Conference</td>
</tr>
</tbody>
</table>
Feeder link standardization efforts

**Fixed Link Including Feeder Link**

**WRC-19 Agenda Item 1.14**

- **6.5GHz**
  - 160MHz
  - 5 countries → Worldwide

- **28GHz/31GHz**
  - 600MHz
  - 23 countries → Worldwide

- **47GHz**
  - 600MHz
  - Worldwide

- **21GHz**
  - 600MHz
  - North America & Latin America

- **26GHz**
  - 3250MHz
  - North America & Latin America

- **38GHz**
  - 1500MHz
  - Worldwide

*Study towards WRC-19 Agenda Item 1.14*
HAPS feeder link standardization proponents

AIRBUS  facebook

SoftBank + Others
HAPSMobile has entered into a technology licensing agreement with Facebook for their advanced communication system.

※FWA : Fixed Wireless Access
HAPS Progress in Japan
Millennium Project started in 1999

Pathfinder Plus

Source: NASA (https://www.nasa.gov/)
Success of stratospheric flight in 2002

Altitude 20 km (stratosphere)

Stratosphere fixed point communication flight: 4 hours
Night flight impossible due to insufficient power performance
Formula for Implementing Stratospheric Base Stations

(Required specification = altitude: above 20km, continuous flight period: 6 months)

\[ W/S = (\rho C_L)^{\frac{1}{3}} \left[ R \left( \frac{L}{D} \right) \frac{\eta_{\text{cells}} \cdot \eta_{\text{motor}} \cdot \eta_{\text{geardrive}} \cdot \eta_{\text{propeller}}}{\left(1 - \text{night} \right) + \text{night} / \eta_{\text{battery}}} \cdot [1 + Ps] \right]^{\frac{2}{3}} \]

<table>
<thead>
<tr>
<th>Required performance</th>
<th>Solar panel power efficiency</th>
<th>above XX%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Battery capacity density</td>
<td>above XXXWh/kg</td>
</tr>
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</table>
2016.10

Discovered that battery and solar panel performance will catch up

Required Performance

Meet the required performance in 2019
2017.4

Aircraft design starts
2017.12
Stratospheric platform business entity established
Aircraft Development Partner

Wahid Nawabi  
President & CEO

- **Founded**
  1971

- **Head Quarters**
  Simi Valley, California, United States

- **Main Business Activities**
  As the largest unmanned aircraft supplier
  - Development of unmanned aircrafts & systems
  - Produce and Supply them
Gossamer Condor
Human Power (1977)
First successful human-powered airplane

Pathfinder
71,504 feet / (1997)
World’s first solar-powered high altitude UAS

Pathfinder Plus
80,201 feet / (1998)
World’s first 3G and HDTV connectivity from stratosphere

Helios
96,863 feet / (2001)
World’s highest flying aircraft in level flight
World's first 3G and HDTV connectivity from stratosphere

World's highest flying aircraft in level flight

First successful human-powered airplane

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HAWK30
Next Gen HAPS (2019)

HAWK30 rollout at AeroVironment HAPS Innovation Center
Company Overview

Company Name: HAPSMobile Inc.

Founded: December 21, 2017

Capital: 12,000,000,000 JPY

Headquarters: 1-9-1 Higashi-shimbashi, Minato-ku, Tokyo, Japan

President and CEO: Junichi Miyakawa

Main Business Activities: Research, development, production, operation and management of HAPS and network equipment
Business Concept

Build a new infrastructure globally

Stratospheric Platform
HAPS

Ground Relay Station
Gateway
Create a new generation with HAPS

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<td>Altitude 36,000km</td>
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<td>Altitude 20km</td>
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OneWeb
One World

We're launching the first 5G-ready network in space. Providing broadband access for everyone, everywhere. On land, at sea, and in the air.
動画をご覧ください
HAPS Mobile’s “HAPS”

Stratospheric Aircraft

HAWK30
HAWK30 completed

Front side view
HAWK30 completed
HAWK30 Features

- Low resistance: minimizes flight energy with a tailless aircraft
- Versatile: large payload and large power supply are possible
- Mass production: simple structure uses carbon pipes (spar)
Scheduled to provide service around 2023 after flight tests and commercial production
Aircraft Performance

HAWK30

HAWK50

[World Map with aircraft performance zones labeled as +50, +30, 0, -30, -50]
Deliver Internet connectivity to all people around the world
February 2019
OneWeb
Successful satellite launch
Using OneWeb’s backhaul

Mobile devices, etc.

Internet

Mobility / enterprises / base stations
Today’s challenge will be tomorrow’s normal
Stratospheric platformer with a common vision
Deploying HAPS service using balloons

- Ability to predict winds & steering of balloon
- Aircraft that can be controlled remotely
About Loon

Subsidiary of Alphabet, Google’s parent company

Basic research for various advanced technologies

Spun out from X, launched commercial services

Loon
Stratospheric connectivity platform

Waymo
Self-driving car service

Wing
Drone delivery service
BALLOON-POWERED CONNECTIVITY
ENGINEERED FOR THE STRATOSPHERE
A PROVEN FLIGHT VEHICLE
A PROVEN COMMUNICATIONS PAYLOAD
OPERATING AT SCALE
OVER 35 MILLION KILOMETERS FLOWN
INNOVATIVE TECHNOLOGY

SOFTWARE DEFINED NETWORKING

HIGH ALTITUDE FLEET MANAGEMENT

HAPS-TO-HAPS CONNECTIONS

Peru

Colombia

Brazil
OVER 300,000 PEOPLE CONNECTED
Alphabet spins drone and internet balloon projects into independent companies

Google's Loon brings internet-by-balloon to Kenya

Loon will sell its next-gen networking tech to satellite company Telesat

Satellite company Telesat will use Loon's networking software to manage low Earth orbit constellations
A VISION FOR THE FUTURE OF CONNECTIVITY

HAPS MOBILE

LOON™
Strategic Relationship
Strategic Capital Relationship
HAPS to invest in Loon ($125M)

*Loon retains a right to invest at the same amount
Why are competitors joining hands?
Using the stratosphere = major challenge
Working towards the same goal
And to spread stratospheric telecommunications even faster and wider to more people around the world…
Potential Technical/Business Collaboration

Wholesale business
Integration of gateway services

Payload joint development
HAPS to HAPS interconnection

Optimization of fleet management system
Create HAPS alliance
Wholesale Business

LOON

HAPS MOBILE
Joint development of payload adaptable to multiple flight vehicles and ITU compliant frequency bands
Optimization of Fleet Management System
Integration of Gateway Services

From 2023
HAPSMobile

From 2019
LOON

Internet

Backhaul

GW

HAPSMobile
H2H – HAPS to HAPS Interconnection —
Create HAPS alliance
Alphabet

Smile for All
Revolutionize the world’s mobile networks