THE FUTURE IS

UP IN THE SKY

TELCO2 SANOG 30 2017

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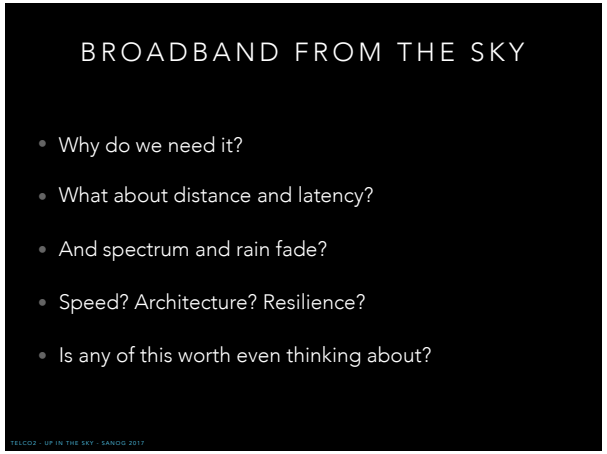
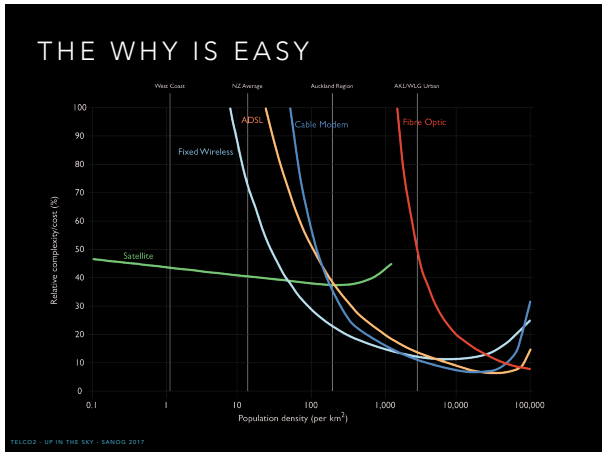


2

We're going to talk about Satellite Broadband today. So here are a few of the points we'll cover - but really what I want you to take away is a little bit of language. I want you to learn three terms to talk about satellite orbits, and three terms to talk about satellite spectrum. But first…



3

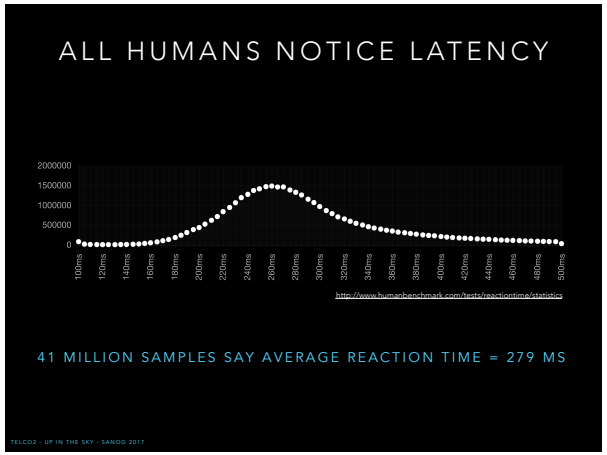
Why does satellite matter?

This chart is based on one from Communications Research Canada, and is probably fifteen years old by now. You've got population density per square kilometre along the X axis. Y axis is a comparative measure of cost and complexity. Today with gPON and 700 MHz LTE the fibre & fixed wireless curves are pushed to the left a bit, but there are still curves, and they still cross.

What matters here is that as population density thins out, satellite becomes the least costly and complex method of delivering broadband.

4

The thing is, latency matters a lot to broadband.



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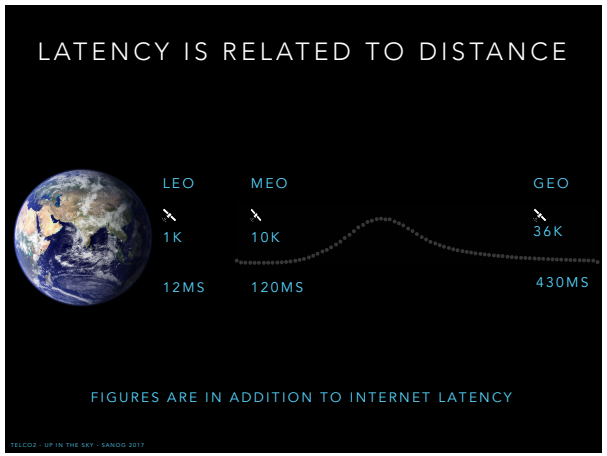
Once you get past say 320 ms to deliver a piece of information to a screen, people are going to notice it's slow. This is science, not opinion. 41 million samples worth of science, not opinion.



6

This view is roughly to scale, and I've put the curve where it belongs. We'll get to definitions of LEO, MEO, and GEO in a bit. For now the take-away is that that most satellite services we know and use today are of the GEO variety - with latencies of more than 400ms. On satellite, the Internet feels slow to pretty much everyone.

UP IN THE SKY = RADIO WAVES

- Positive: Waves in air travel nearly speed of light
  - 40% faster than waves in fibre optic cables
- Negative: Things in the air can attenuate waves
  - Rain, snow, birds, swarms of locusts, x-men
- Neutral: Different frequencies = different properties

7

Most of you know I do a few things with radio, and it happens that all the principles of radio communications hold true even when one end of the link is up in the sky. So we've got a few things to think about.

FREQUENCIES ARE NEUTRAL

- Higher frequencies are great
  - Far more spectrum & thus more bits
  - Higher reusability of spectrum
  - Smaller, higher gain antennas
- Lower frequencies are great
  - Little to no rain fade in lower bands

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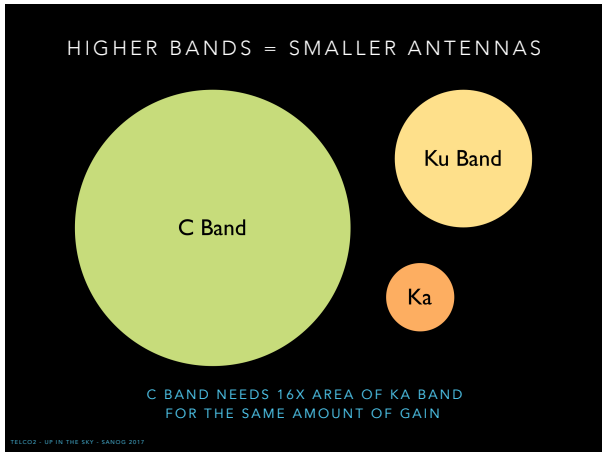
There's a lot more radio spectrum available in higher bands, so it can carry a lot more data.

Reusability is really important - higher frequencies can be re-used many times on the same satellite with directional "spot beam" antennas.

And as we'll see in a moment, higher frequencies use smaller antennas.

However the title of the slide is that is that frequencies are neutral. They're just a thing to be engineered around, with positives and negatives all around.



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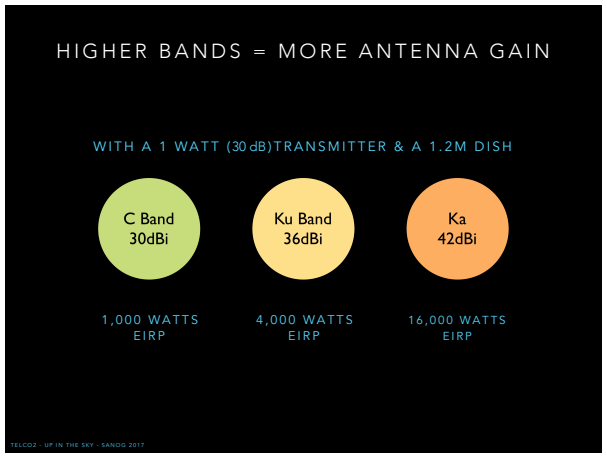
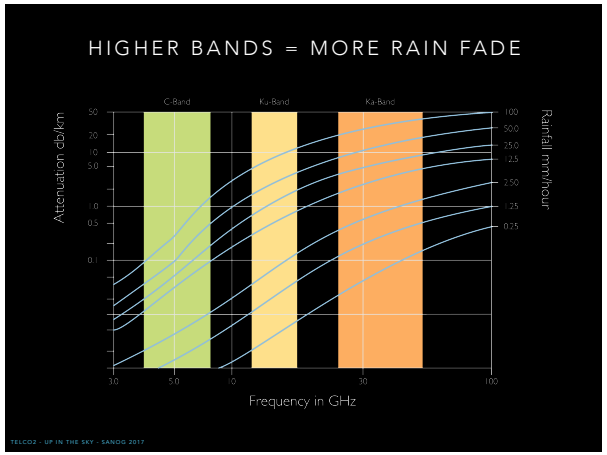
Here we've got three antennas, all with the same theoretical gain. Now on the ground it's ok to install huge dishes, but on satellites antennas tend to be pretty small.



10

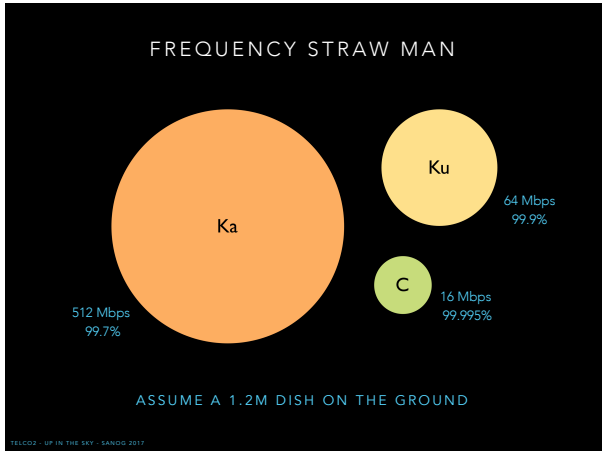
So these are pretty striking figures. With the same size dish you get can get 16x the gain at Ka as you can at C band.

Seems like Ka band is the win. Smaller dishes, more antenna gain, more spectrum, more bits… it's great…



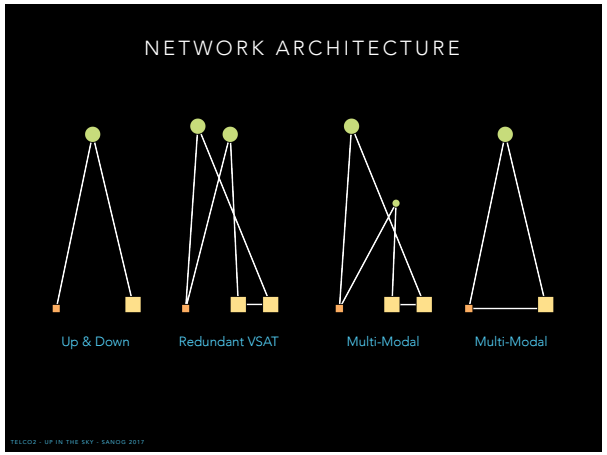
11

It's great until you take rain fade into consideration.
If you remember a couple of slides back, I said "frequencies are neutral". With those higher frequencies and higher gain, you also have far higher rain fade. And that higher power doesn't always make up for the dramatically greater rain fade suffered by these higher frequencies.



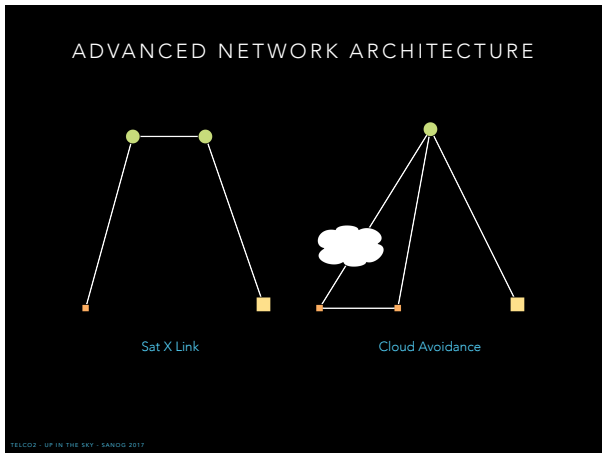
12

This is a straw man, and these are rough numbers. But to give you a rough idea, with the same sized dish on the ground, this is what you might get in terms of throughput and availability.
You can get better than 99.7% uptime on a Ka band service - even five nines - but you need a six or seven meter dish to make that happen.



13

Green ball is our satellite. Little orange square is our remote network, and big yellow square is our earth station.

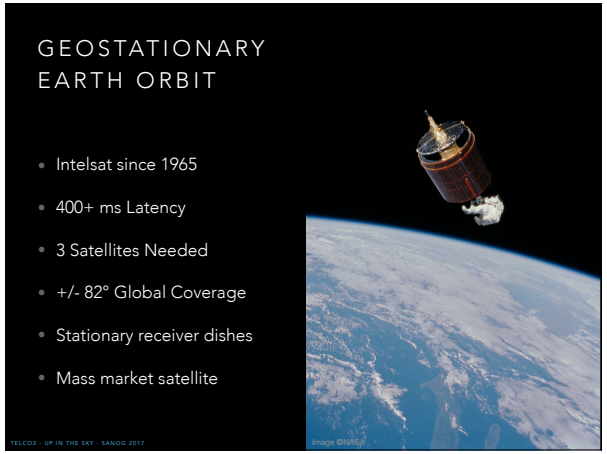


14

This is a real architecture coming into play, in particular due to the fact that tropical rainstorms rarely have intense cells that cover entire islands at once. We'll see a crazy application for this a bit later.

15

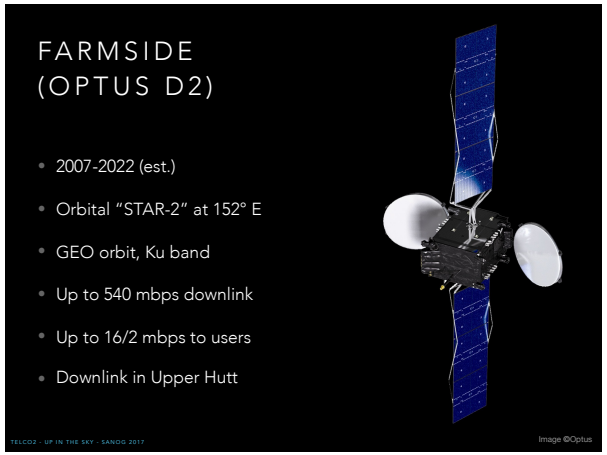
Ok I’m going to introduce the three orbit levels, and at the same time a couple of networks per level.



16

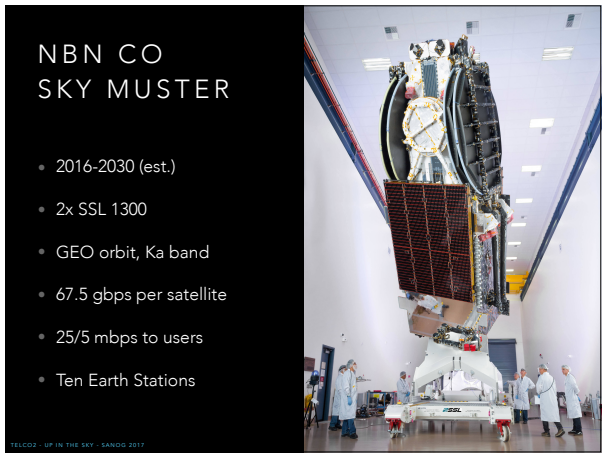
Geostationary orbit is around 36,000 km away from Earth.

NASA image: https://images.nasa.gov/#/details-51a-104-029.html “Astronat Dale A. Gardner achieves a hard dock with the previously spinning Westar VI satellite. Gardner uses a "stinger" device to stabilize the communications satellite.”



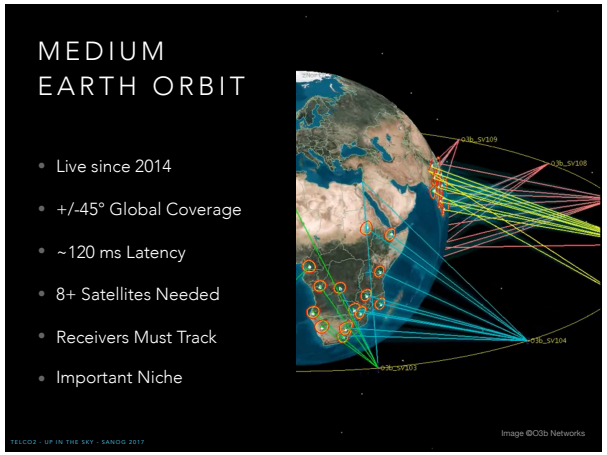
17

Optus D2 is a 1,160 kg satellite, around 2m by 4m.
Capacity numbers are not published by Farmside or their gateway provider, however radio license 164431 shows a 54 MHz channel from Upper Hutt to Optus D2. The best Newtec satellite modems on the market today do around 10 bits per hertz, so I think I'm being generous with 540 mbps.



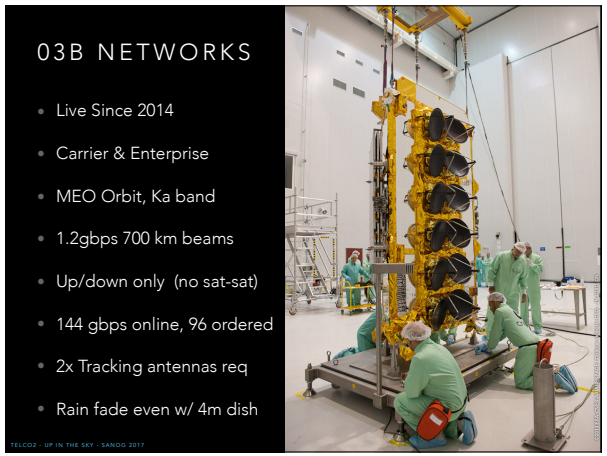
18

We're looking at the second NBNCo Sky Muster satellite, and I left some engineers in for scale. This one project is putting 135 gbps of capacity in the skies over Australia. It's Ka band, which means it will have rain fade issues, but for the most part its remote users are in places it doesn't rain a lot. Still at least 430 ms latency from its GEO orbit, but heaps faster than New Zealand's farmside service.
It's also more than 6 metric tonnes, five times bigger than Optus D2 and one of the largest communications satellites in operation.



19

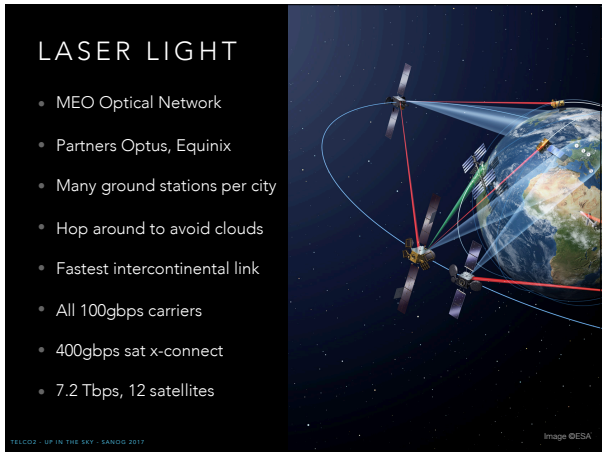
Medium Earth Orbit starts around 8,000 km away from Earth.



20

O3b has revolutionised telco networks in the Pacific, and it's what got me interested in modern satellite systems. It has its problems though - namely rain fade. In O3b's launch market, the Cook Islands, service to its 4 m dishes regularly fades for a minute or two at a time when ever it rains heavily. In American Samoa where carrier ASTCA installed 7 m dishes, there are still occasional fades. ASTCA combines O3b with a limited amount of fibre connectivity via MPLS tunnels to deliver a robust hybrid solution.

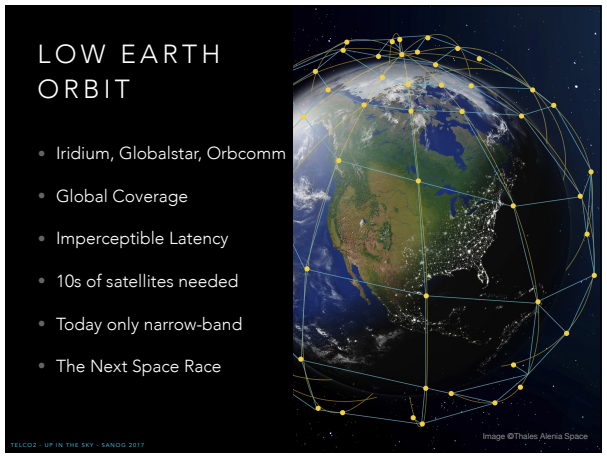
As you can see this is not a big satellite. It's 450kg, so the entire operational cluster of O3B today weighs less than one Sky Muster satellite.



21

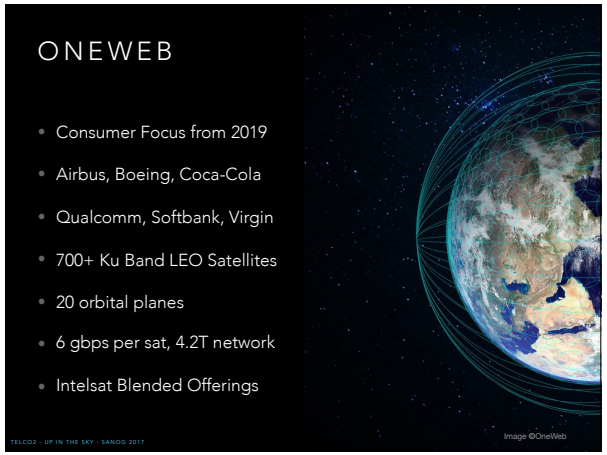
Laser Light intends to be the world's first all-optical satellite network. It will be the world's fastest intercontinental link, and will concentrate on linking data centres, corporations, and government/military sites. Laser is especially attractive to government users as it can't easily be eavesdropped.

Image: http://www.esa.int/spaceinimages/Images/2016/02/Inter-satellite_laser_links



22

Low Earth orbit is the new space race. Several companies intend to launch thousands of new satellites into North-South polar orbits around 800-1,200 kilometres from Earth.

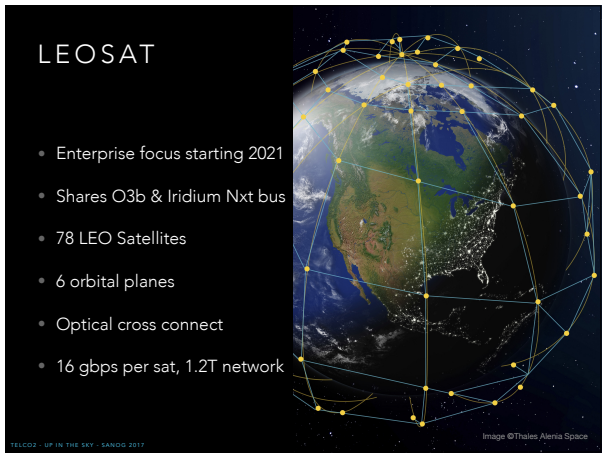


23

Greg Wyler, who founded O3b, has pulled in 1.7 billion in investment for a project that could take 3-4 billion in total.

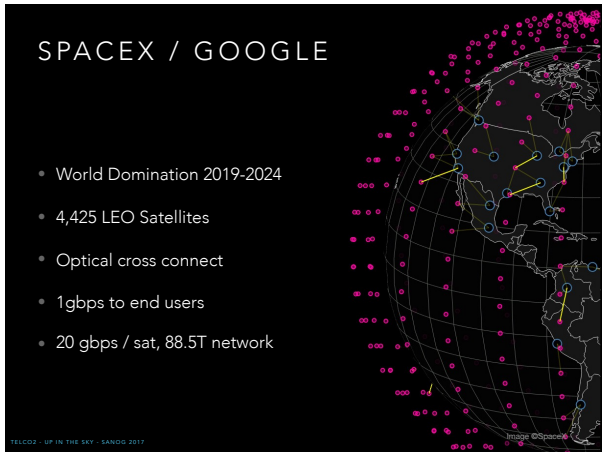
They've already started making tiny, tiny satellites, only 150 kg each, for their network. These satellites are 1/40th the size of Sky Muster.

Their "Progressive Pitch" antenna technology will allow re-use of Ku band frequencies already in use by other satellites without interference.



24

LeoSat is a European venture partnered with Thales Alenia Space. It will use the same satellite platform as O3b and Iridium Next. Their focus is on the corporate market.



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SpaceX wants to put 4,400 satellites in orbit. Right now there are 1,459 total. As they own their own launch company, they have a very serious chance of success.

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TITAN AEROSPACE SOLARA
PURCHASED BY GOOGLE 2014, SHUT DOWN 2017
Image ©Titan Aerospace

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GOOGLE LOON
Image ©Google

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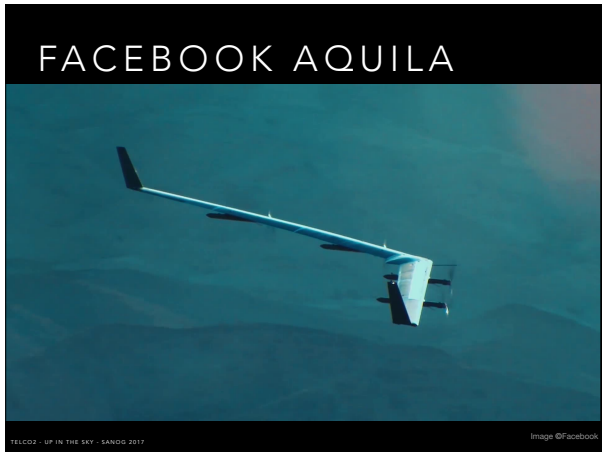

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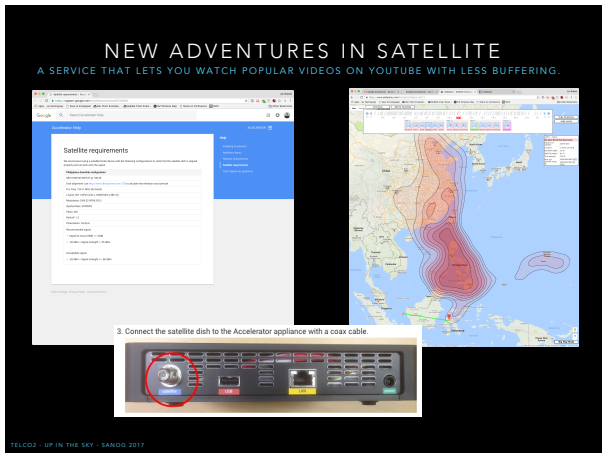

30

Finally a satellite application that's new and special - a service that combines the special properties of geostationary satellites and their ability to broadcast information over a wide area - Google's Accelerate set-top-box for YouTube.

From https://support.google.com/accelerator/?hl=en#topic=6333793 and satbeams

UP IN THE SKY

THANK YOU

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