

Networking The Pacific

Jonathan Brewer
Network Startup Resource Center
jon@nsrc.org



These materials are licensed under the Creative Commons
Attribution-NonCommercial 4.0 International license
(<http://creativecommons.org/licenses/by-nc/4.0/>)



For those of you who don't know me, I'm Jon Brewer, or kiwibrew on the social network of your choice.

In 2004 I founded a wireless network that is apparently still going. I've spent the last four years trying to do interesting things in the telecommunications space.

I'd like to thank the University of Oregon's Network Startup Resource Centre for helping me do interesting things, and for funding some of the activities described in this presentation.



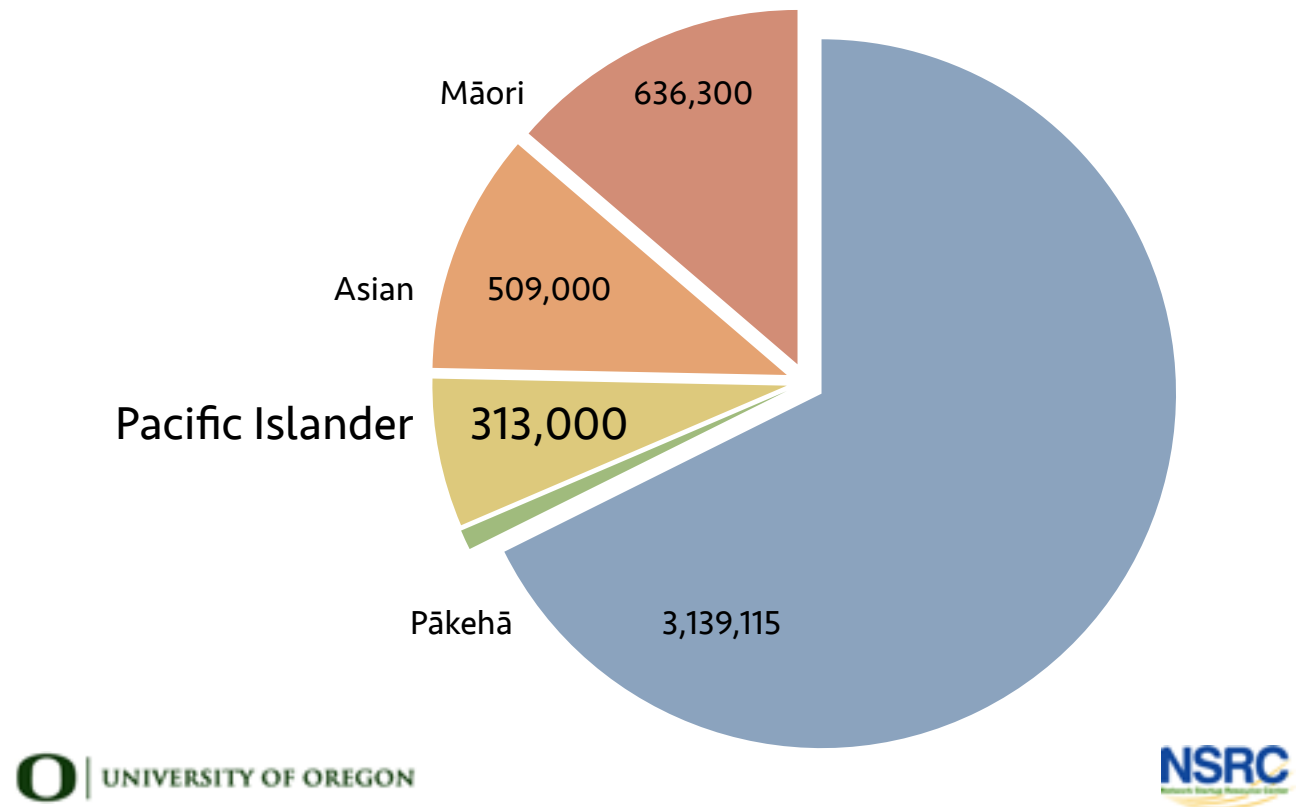
Welcome to sunny Vanuatu. Ten steps to the right is an unbelievable coral reef. Ten steps to the left is an unlimited supply of cold beer. Sounds good, eh?
The Pacific is a paradise and I care for it a great deal.



Why do I care? I've participated in the last four PacNOGs as a trainer for NSRC, helping out with workshops in Tonga, Fiji, Vanuatu, and the Solomon Islands. In every single workshop, our students - most of whom work for local cellular carriers, governments, or universities, have been fun, interesting, helpful, and kind.

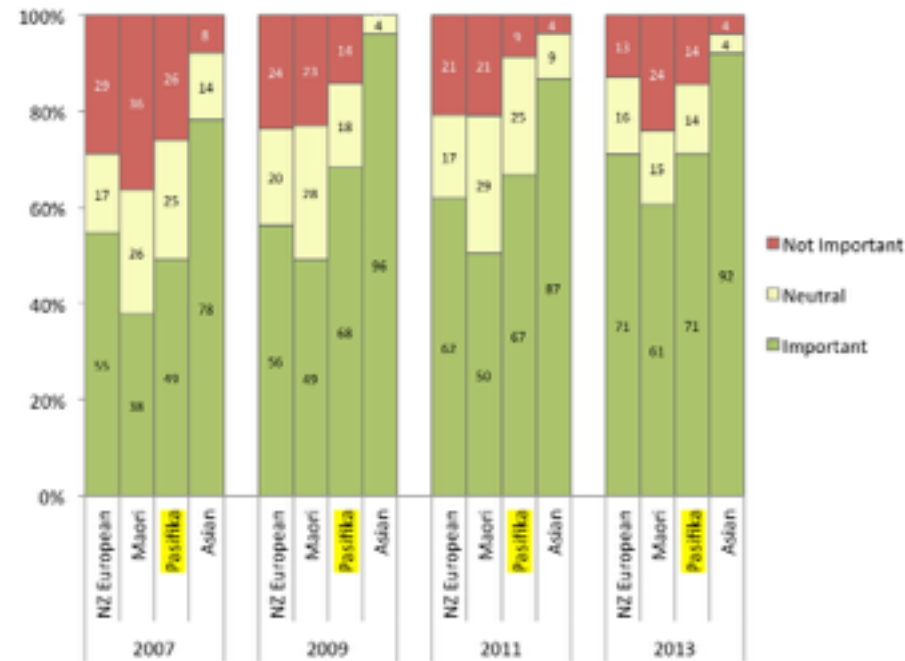
And they've told me about visiting friends and family in New Zealand. Or going to school in New Zealand. And how they see pictures of New Zealand on Facebook. The Pacific Loves New Zealand.

He tangata! He tangata! He tangata!



It shouldn't be a surprise. 7.5% of New Zealand's population is from the Pacific Islands. In a few cases New Zealand is host to the majority of some Pacific cultures. There are strong ties between the people of New Zealand and the people of the Pacific.

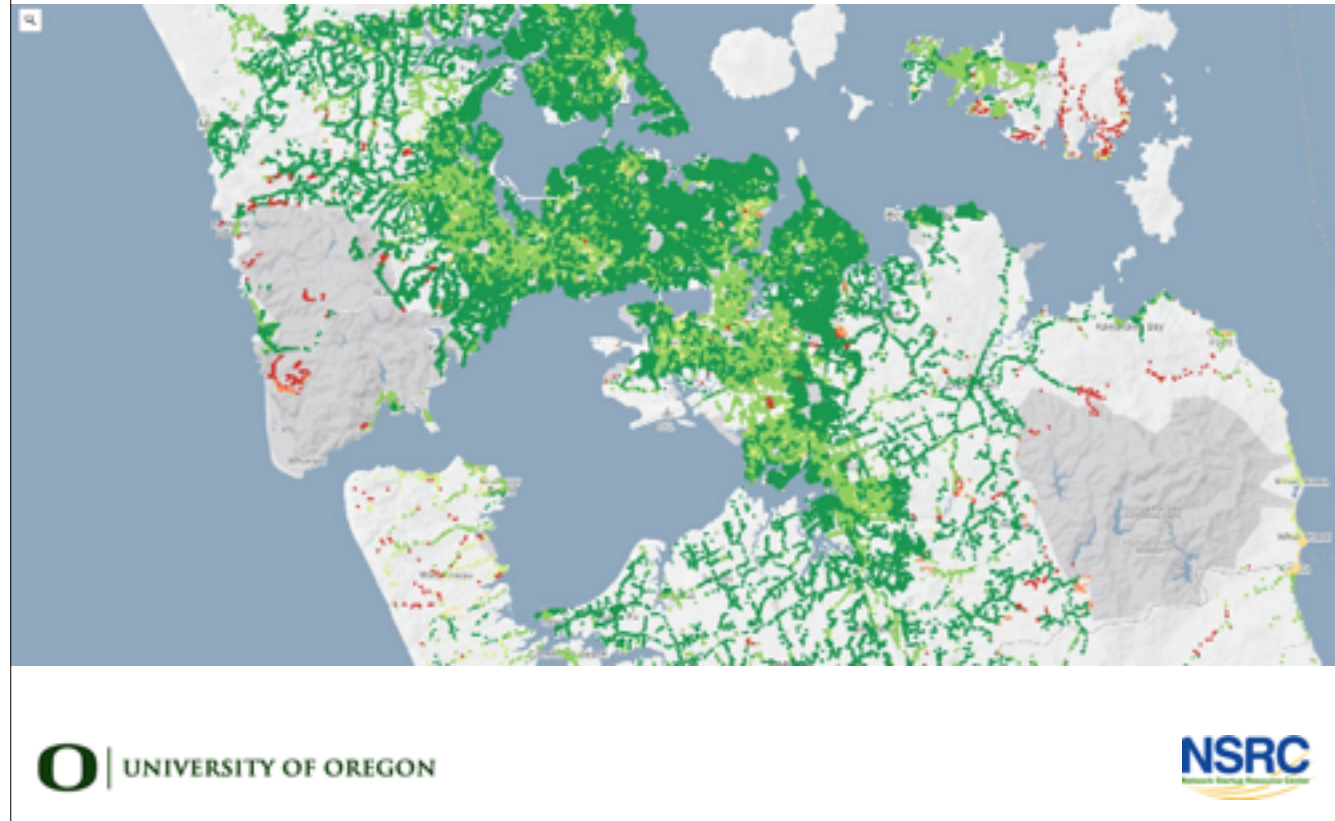
Internet is Important to Pacific Islanders in NZ



WIP/AUT Internet Trends in New Zealand 2007-2013

Perhaps due to the closeness of family relationships in Pacific Culture, the Internet is important. In a 2011 survey, AUT found the Internet to be more important to Pacific people than to Europeans, and in 2013 they found importance on par between the two groups. This is significant due to the large socioeconomic differences between Pacific people and Pakehas in New Zealand.

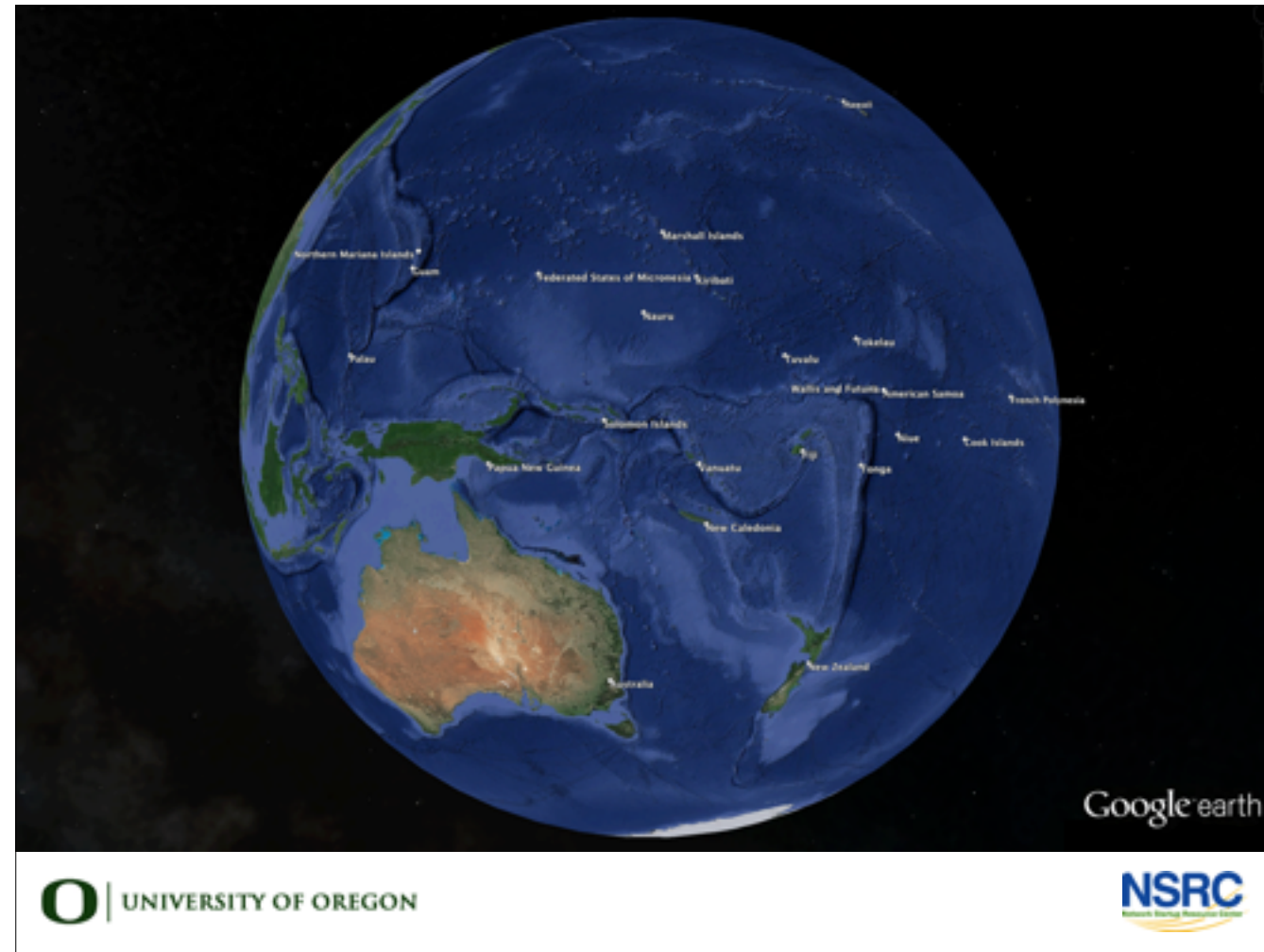
Internet is Affordable for Pacific Islanders in NZ



A study I did in August 2014 looked at affordability of broadband in New Zealand, analysing available connectivity on a per-household level, and median household income on a per-meshblock level. From dark green to yellow are areas where by the ITU's standards, broadband is affordable. And given the majority of New Zealand's Pacific population lives in Auckland, it's fair to say Internet is available and affordable for the great majority here.

Unfortunately it's not for many of their families in the Islands, and as we'll see later, this might have a bearing on Internet uptake in the Pacific.

But enough about New Zealand, let's look at some maps.



For the purposes of this talk, we'll consider the Pacific the set of these islands. Technically Tokelau, Niue, and the Cook Islands are part of New Zealand. American Samoa, Hawaii, Guam, and the Marianas are part of the US. New Caledonia is part of France. You get where I'm going. It's complicated. I'm going to refer to these islands as countries, and I'll just gloss over that when I talk about Hawaii.

So this is the Pacific. It's a long way away from anywhere.

“Fiji”



*“You can't get any further away
before you start coming back.”*



Remember the Truman Show? That was Jim Carey, seventeen years ago.

Carey plays Truman, a guy, who among a lot of other issues,
dreams of getting out of his small town in America.

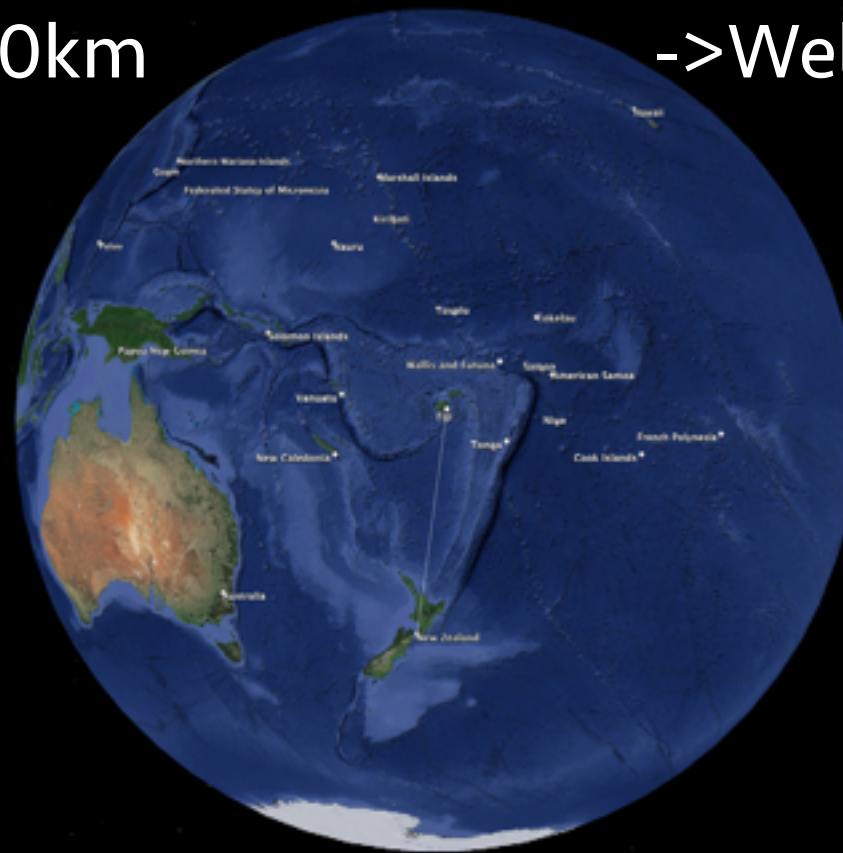
He wants to go as far away as you can possibly go.

For him, that's Fiji.

2,600km

->Wellington

Fiji



Google earth

 UNIVERSITY OF OREGON

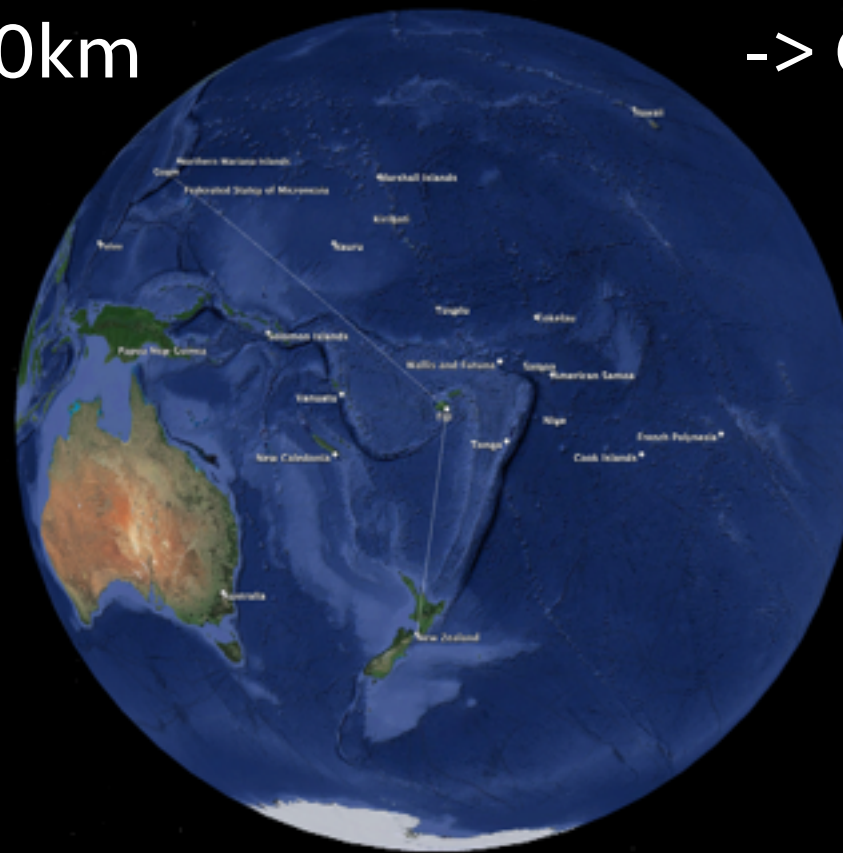
 NSRC

Suva is 2,600 km from Wellington. I looked it up.

5,000km

-> Guam

Fiji



O UNIVERSITY OF OREGON

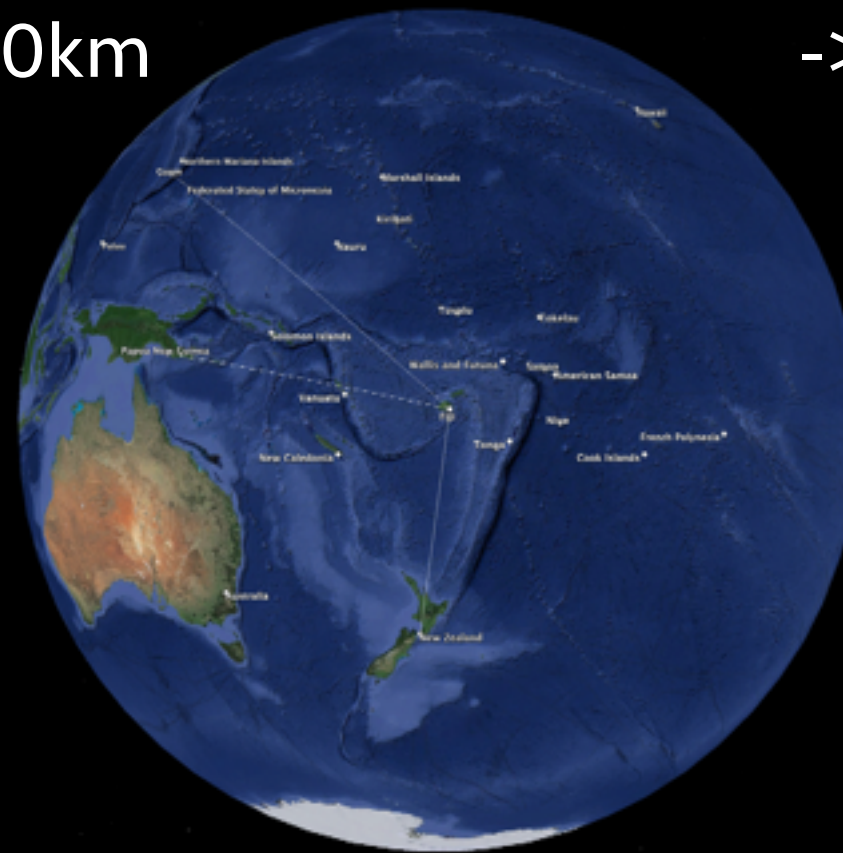
NSRC
NORTH PACIFIC SCIENCE CENTER

It's 5,000 kilometres to Guam. I looked that up too.

3,900km

-> PNG

Fiji



Google earth

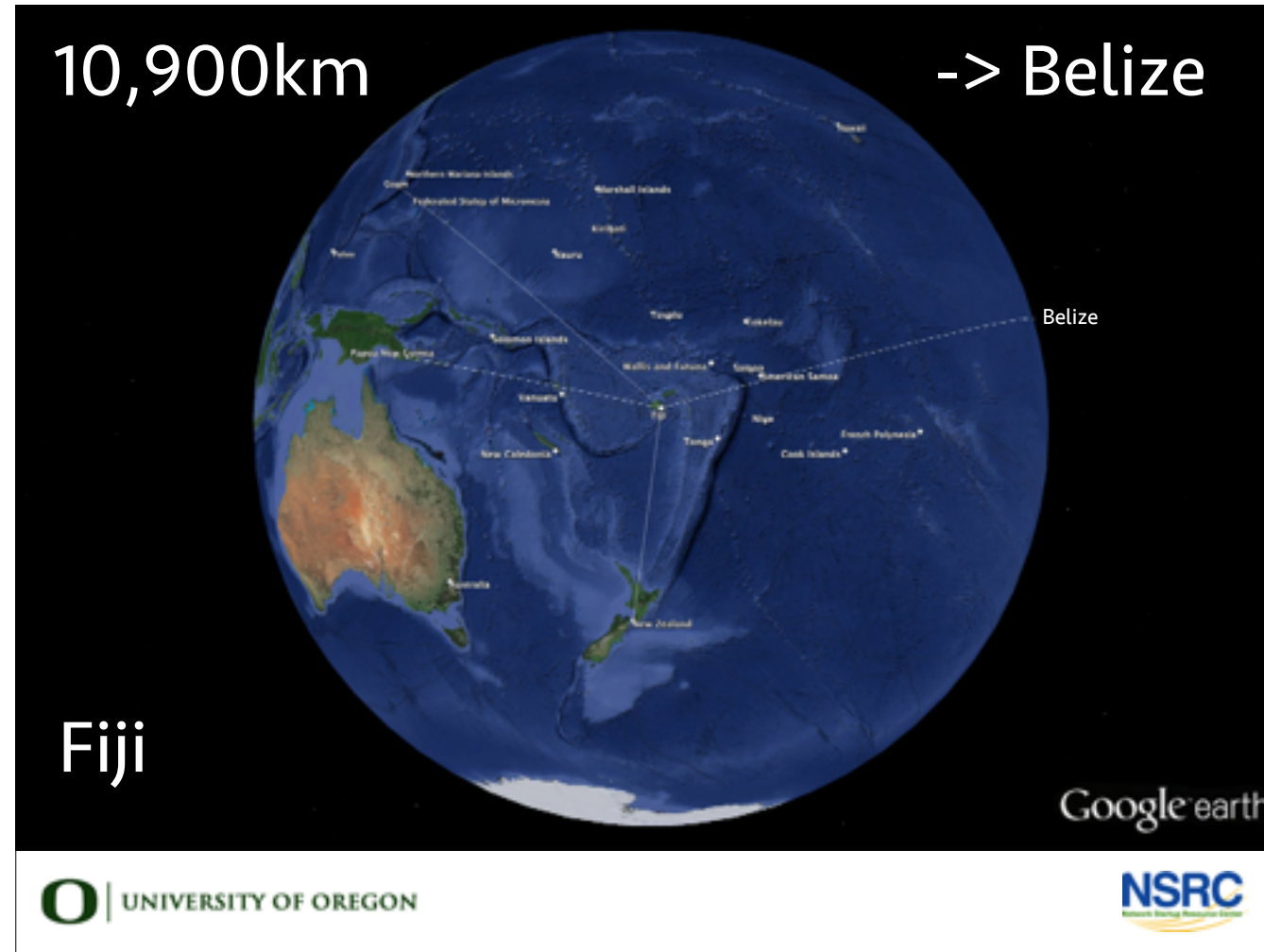
O UNIVERSITY OF OREGON

NSRC
NORTH SOUTHERN RESEARCH CENTER

3,900 kilometres to Port Moresby.

10,900km

-> Belize



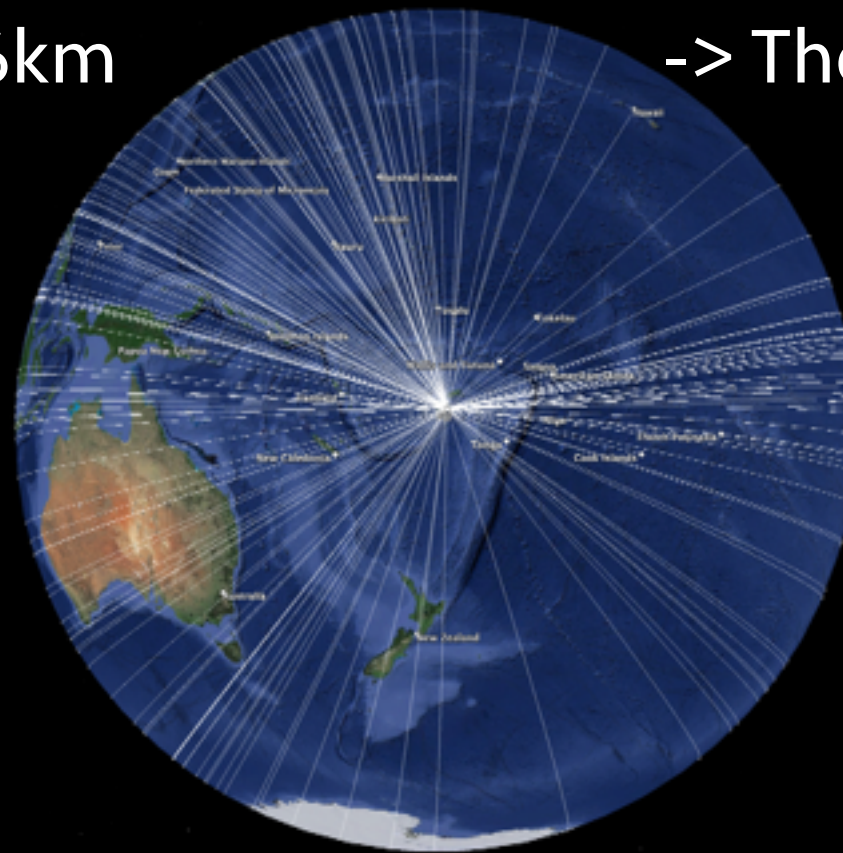
10,900 kilometres to Belize. And yeah, I looked it up.

The whole looking it up thing was getting tedious, so after about 20 goes at Google I grabbed a set of all the capital cities of the world, geocoded them, and wrote a few lines of Python to calculate all the distances from Fiji to everywhere.

14,176km

-> The World

Fiji



Google earth

 UNIVERSITY OF OREGON

 NSRC

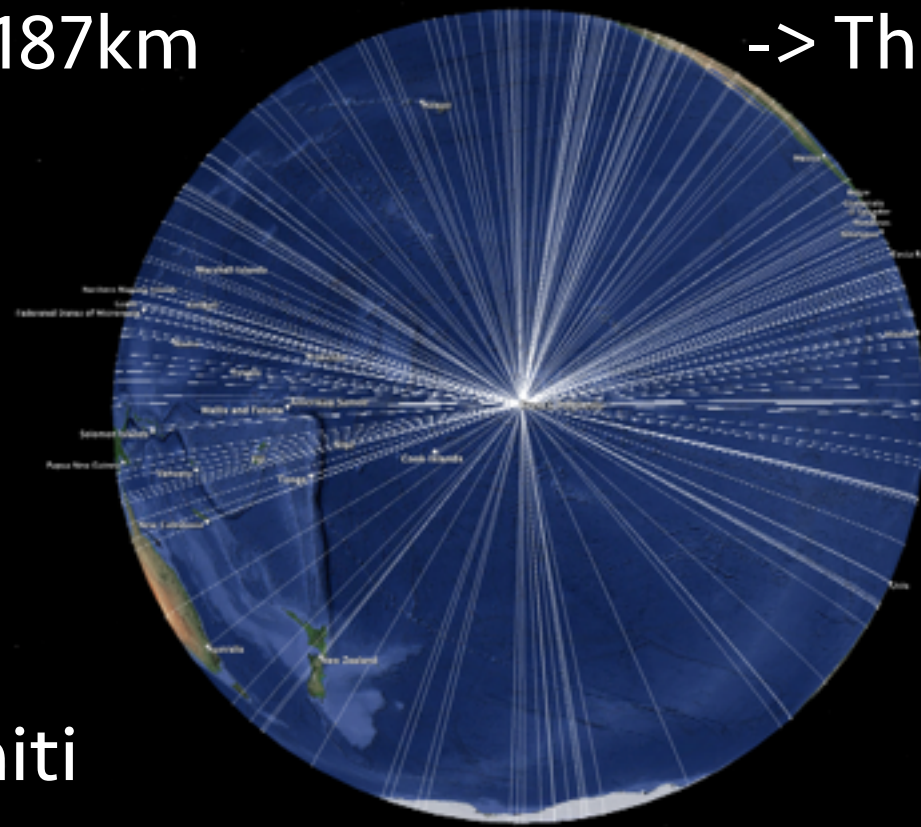
Pick a random country in the world. As it turns out, in most cases Fiji is a long way away. In fact, the median distance from Fiji to all the other countries in the world is 14,176 kilometres.

So was Truman Right? Is Fiji as far away as it gets?

15,187km

-> The World

Tahiti

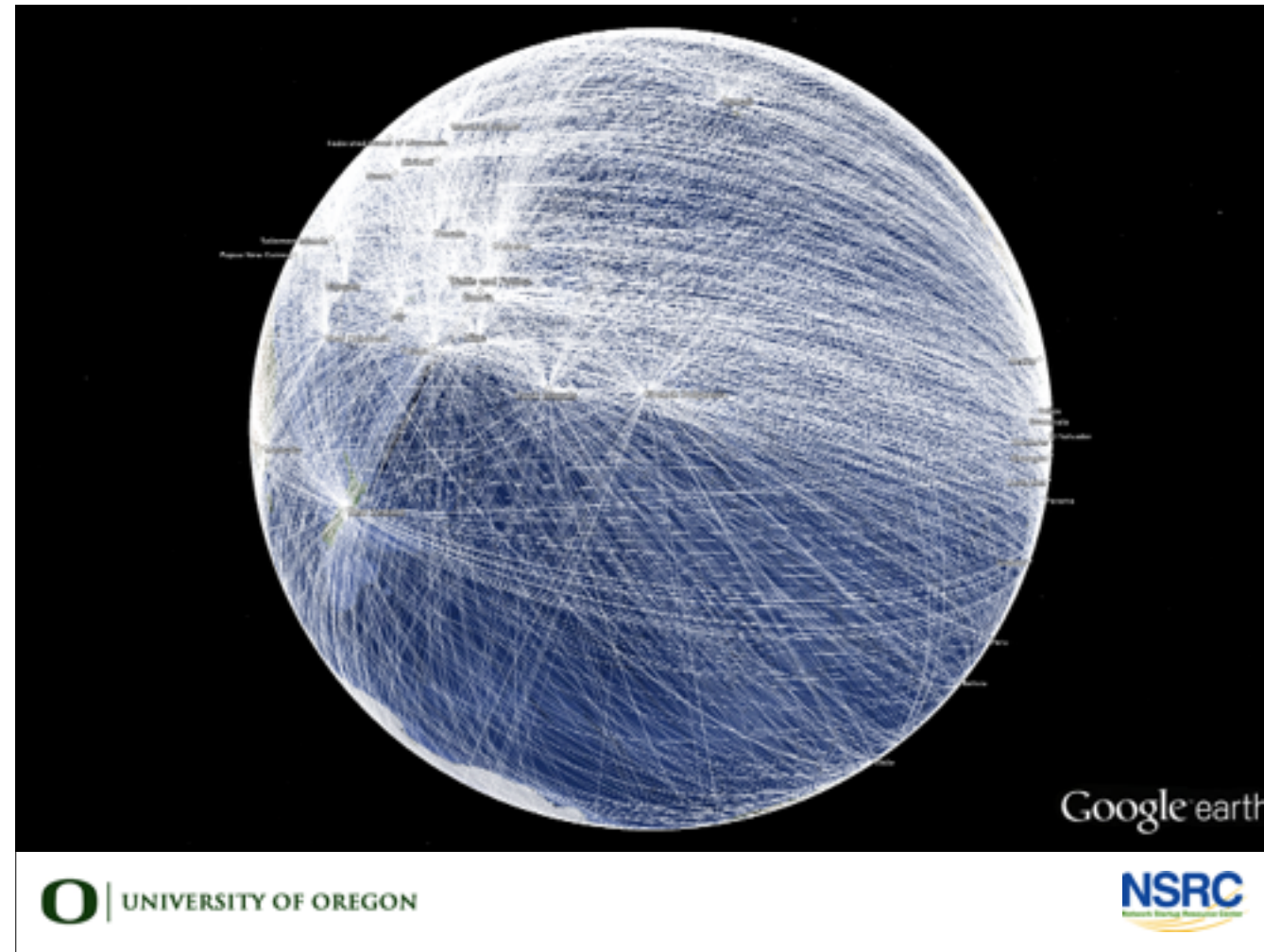


Google earth

 UNIVERSITY OF OREGON

 NSRC

Actually Tahiti is even further away than Fiji.



And if you look at all the options (some more Python here)

15,227km

-> The World

Rarotonga, Cook Islands As Far Away As You Can Get

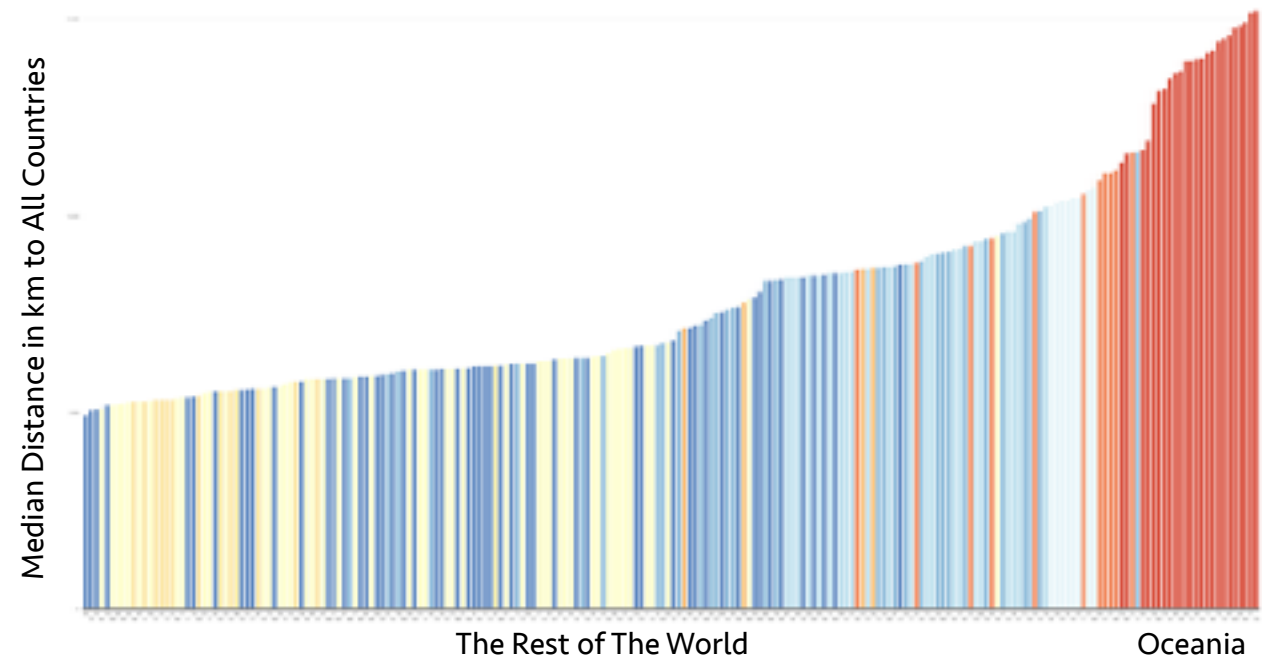
Google earth



Rarotonga has the honour of being the furthest country away from everywhere else in the world.

Well that was fun. Let's look at those distances next to each other.

Pacific Countries Are A Long Way Away



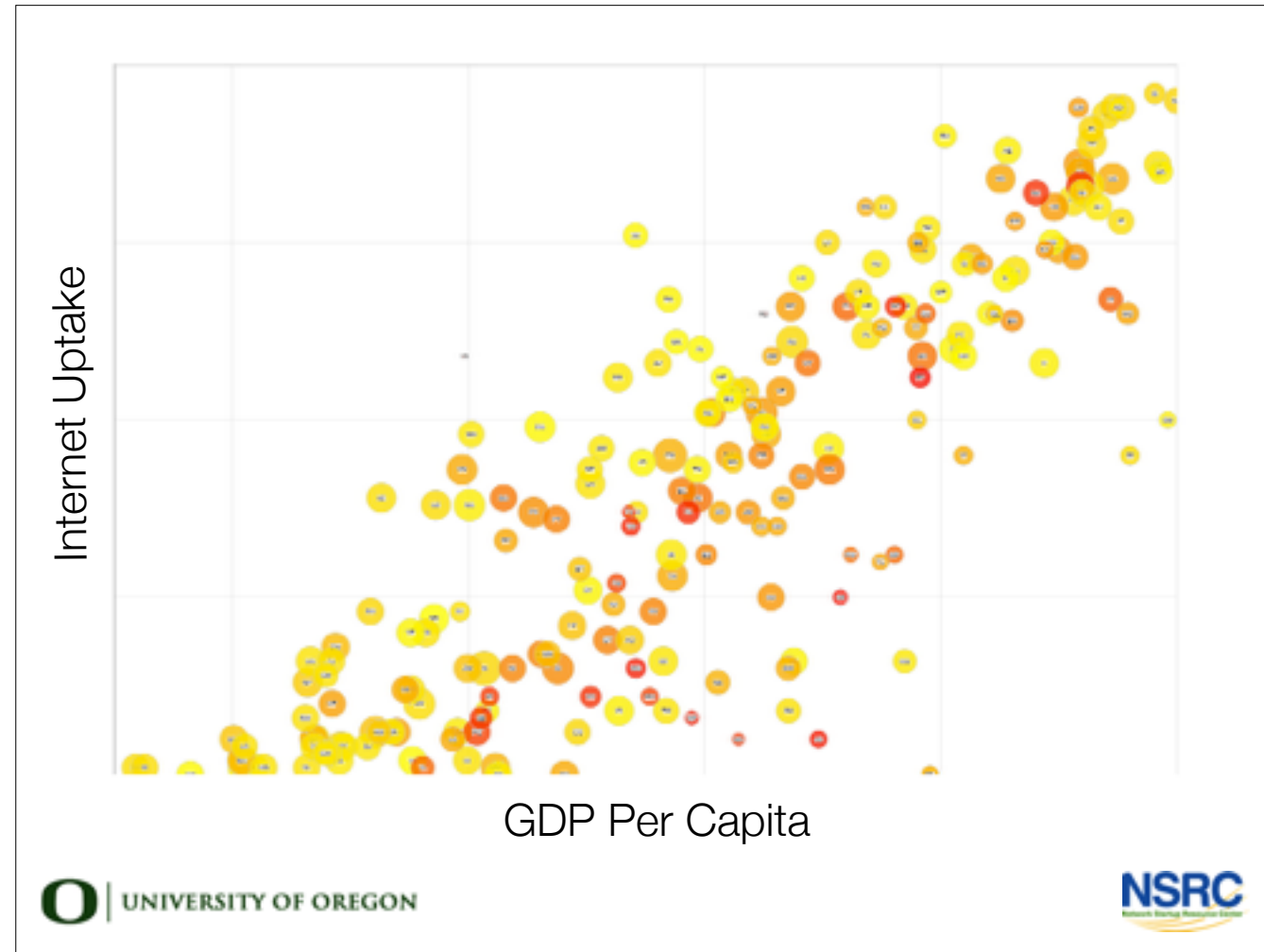
UNIVERSITY OF OREGON

NSRC

I've plotted all the median distances above, and shaded countries on a regional basis. Red is Oceania.

Pacific Countries Are A Long Way Away.

But it's not a very interesting view of the data, and I wanted to know if distance really makes a difference when it came to the use of the Internet.



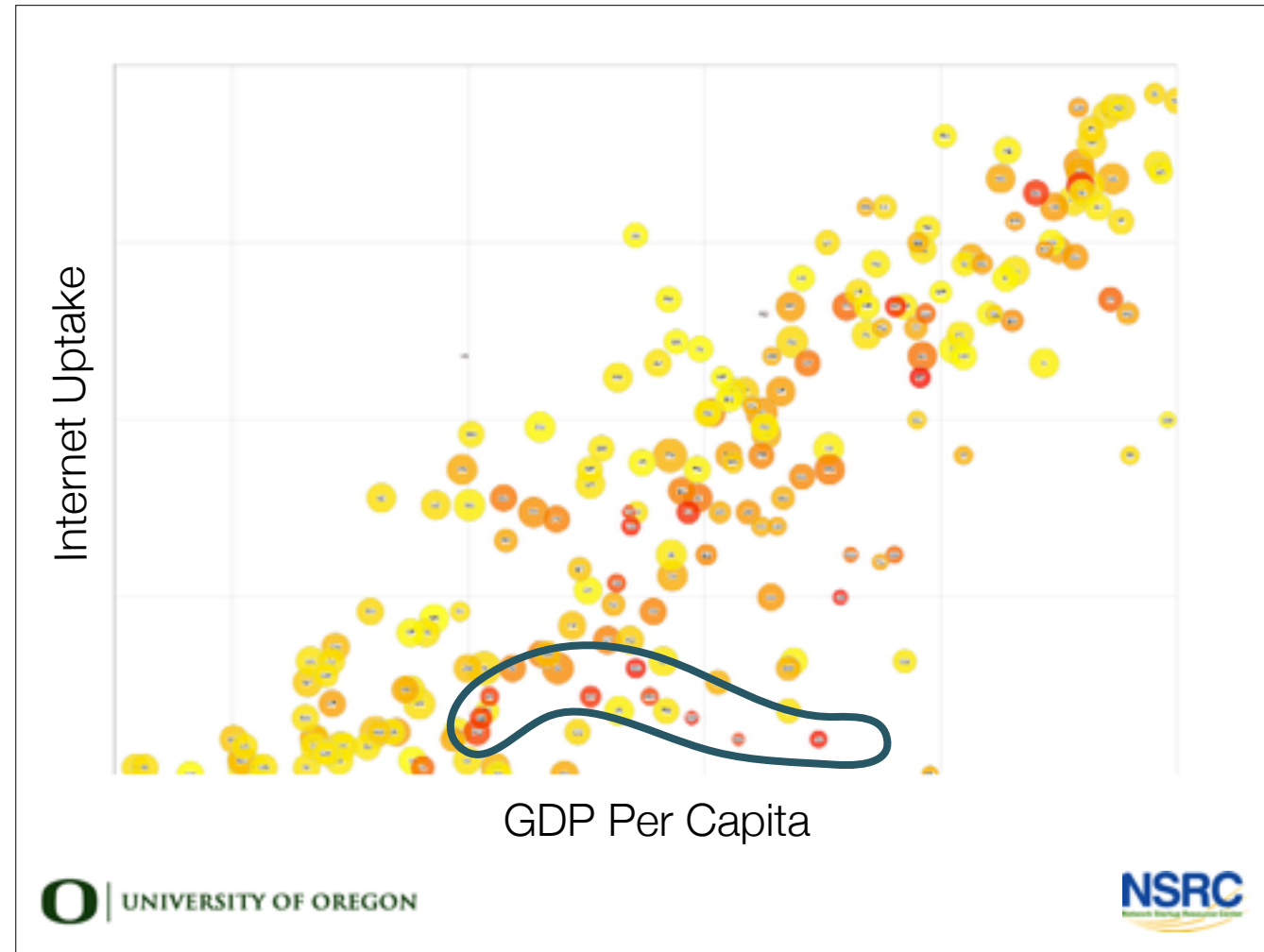
Now this is a bit more useful.

The chart up on the screen has all the same countries plotted with a bit more data I grabbed from the World Bank. Here the Y axis representing Internet Uptake, and the X representing GDP per Capita.

Yellow to Red is a scale of distance - yellow countries are very close to other countries, red are very far away. Size of the bubble relates to size of the country.

I used some log scales to make this data a bit easier to read. Otherwise we'd never see many countries due to the size of China and India, and from a GDP standpoint we'd have Lichtenstein and Monaco breaking the X Axis pretty badly.

It turns out that when you look at Internet Uptake compared to GDP, distance could be a factor in some cases.



In particular, PNG, the Solomons, Kiribati, Vanuatu, Samoa, the Marshall Islands, Wallace and Futuna, Nauru, and American Samoa have lower Internet uptake rates than less-distant peers of roughly the same populations and per capita GDPs.

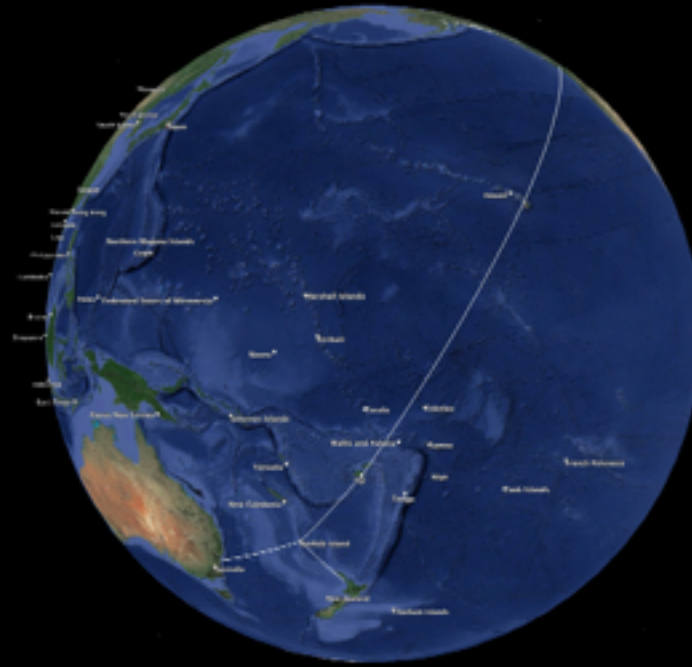
Is it an infrastructure problem? Let's have a look.

A Brief, Non-Exhaustive Survey of Submarine Fibre & Pacific Islands



This talk is about networking the Pacific, so let's have a look at some networks.

In the Beginning

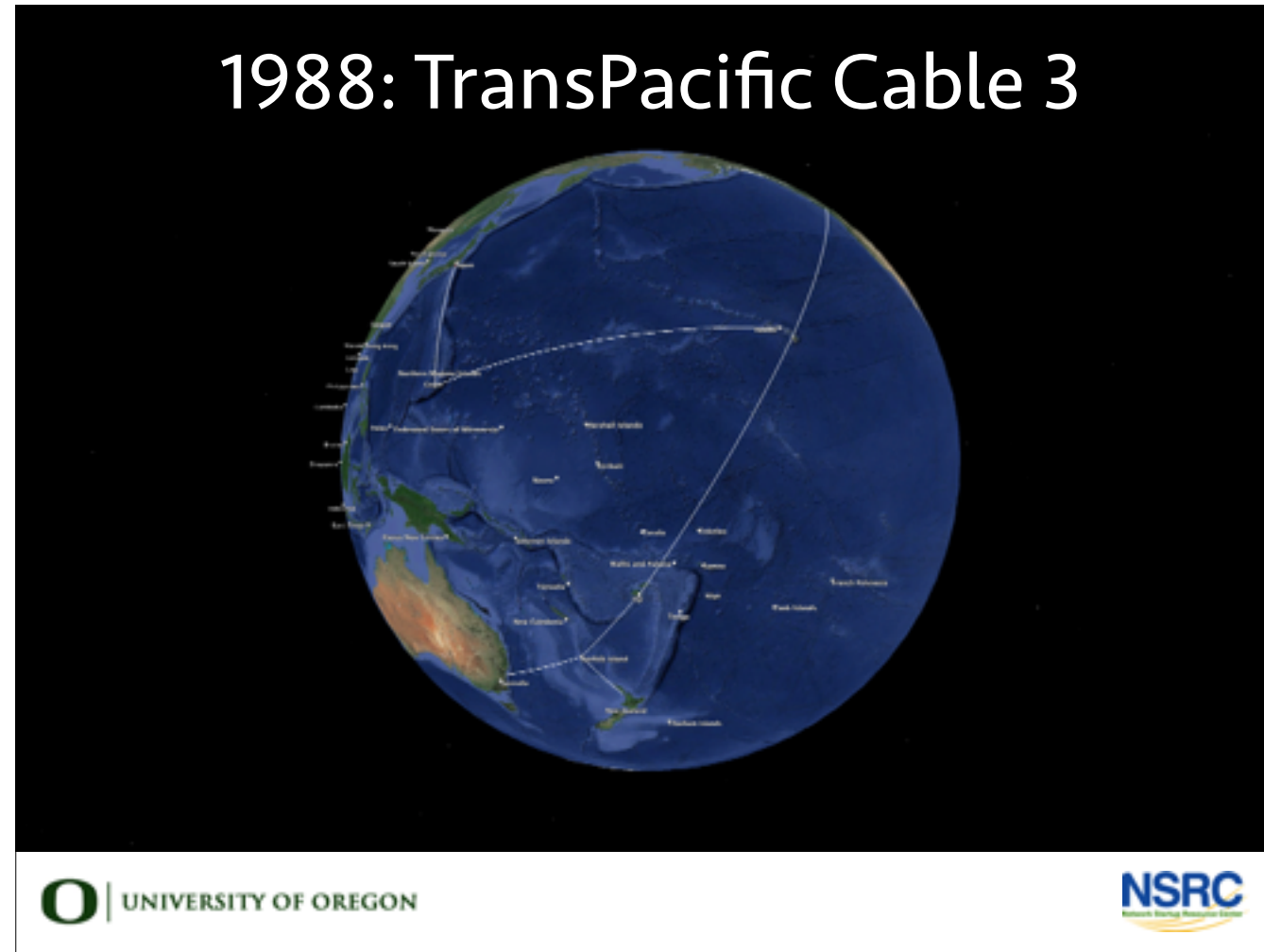


 UNIVERSITY OF OREGON

 NSRC

This was the state of the Pacific in the late 1980s. ANZCAN linked Canada, Hawaii, Fiji, Norfolk Island, Australia, and New Zealand, with 1380 analogue channels, 480 of which branched off to New Zealand at Norfolk Island. ANZCAN wasn't fibre, but it reportedly carried the first Internet traffic to New Zealand.

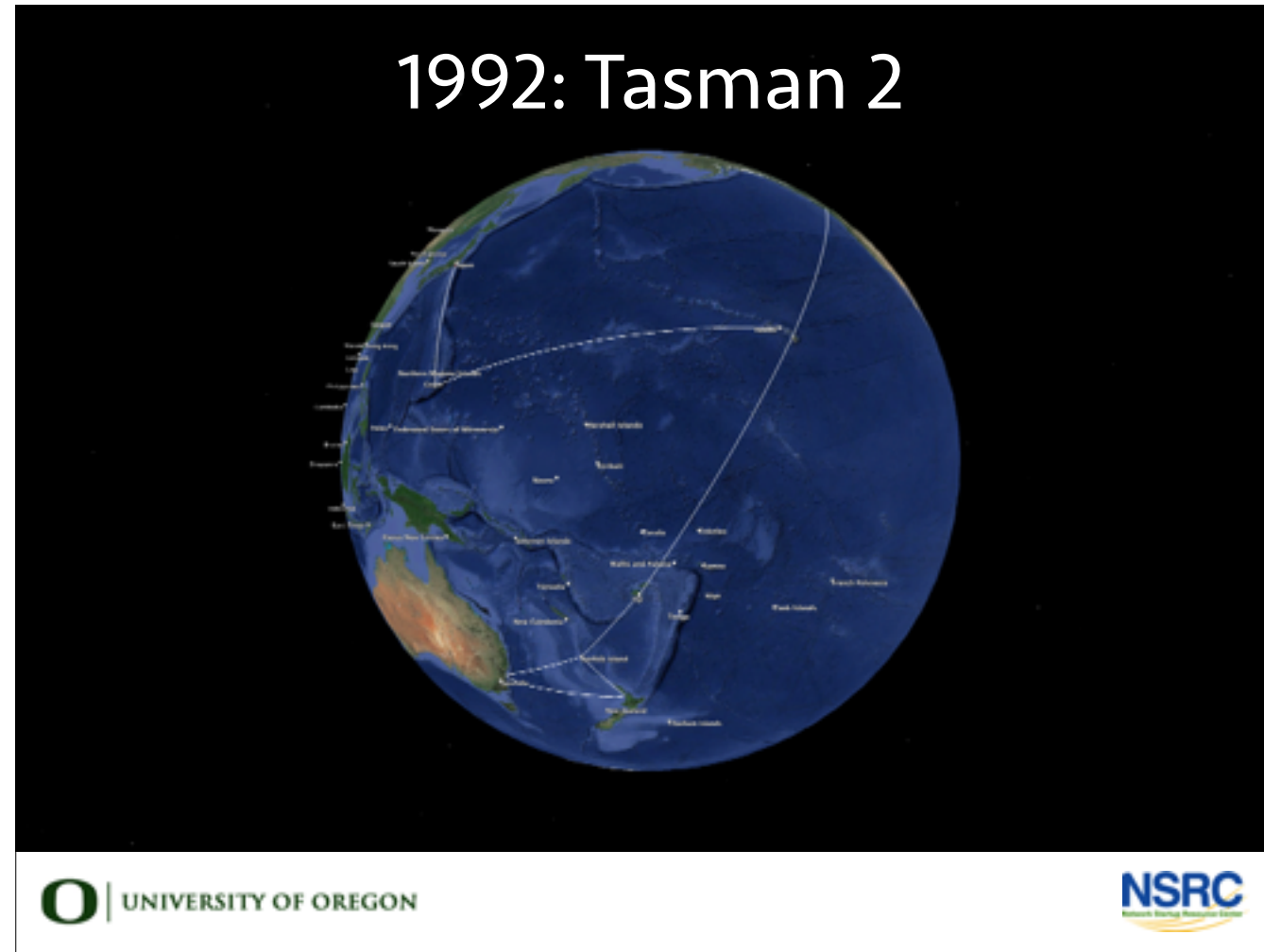
1988: TransPacific Cable 3



TPC3 has the honour of the first commercial submarine fibre optic cable in the Pacific.

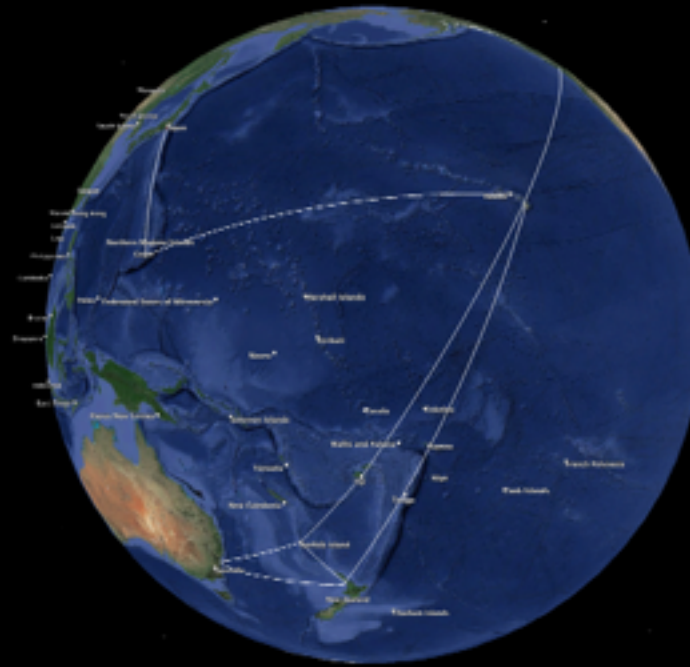
Two fibre pairs, each lit at 280 mbps. The US mainland was connected shortly after in 1989 by HAW-4, a single 280mbps pair from California, after which things quieted down for Pacific Islands for a bit.

1992: Tasman 2



New Zealand's entry into submarine fibre came in 1992 with the lighting of Tasman 2 between Whenuapai and Sydney. Not exactly a standalone project, Tasman 2 was soon joined by...

1993: PacRim East

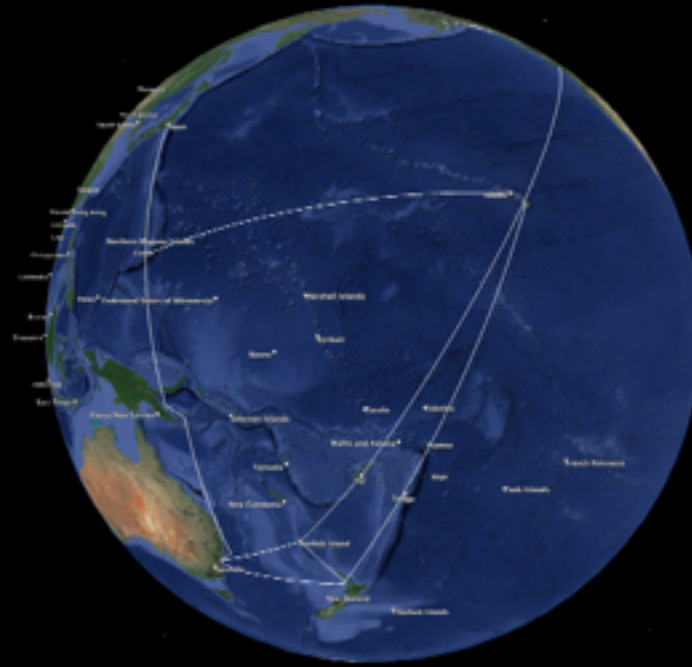


O UNIVERSITY OF OREGON

NSRC
National Science and Research Council

PacRim East, joining Hawaii and Takapuna at 560mbps.

1993: PacRim West

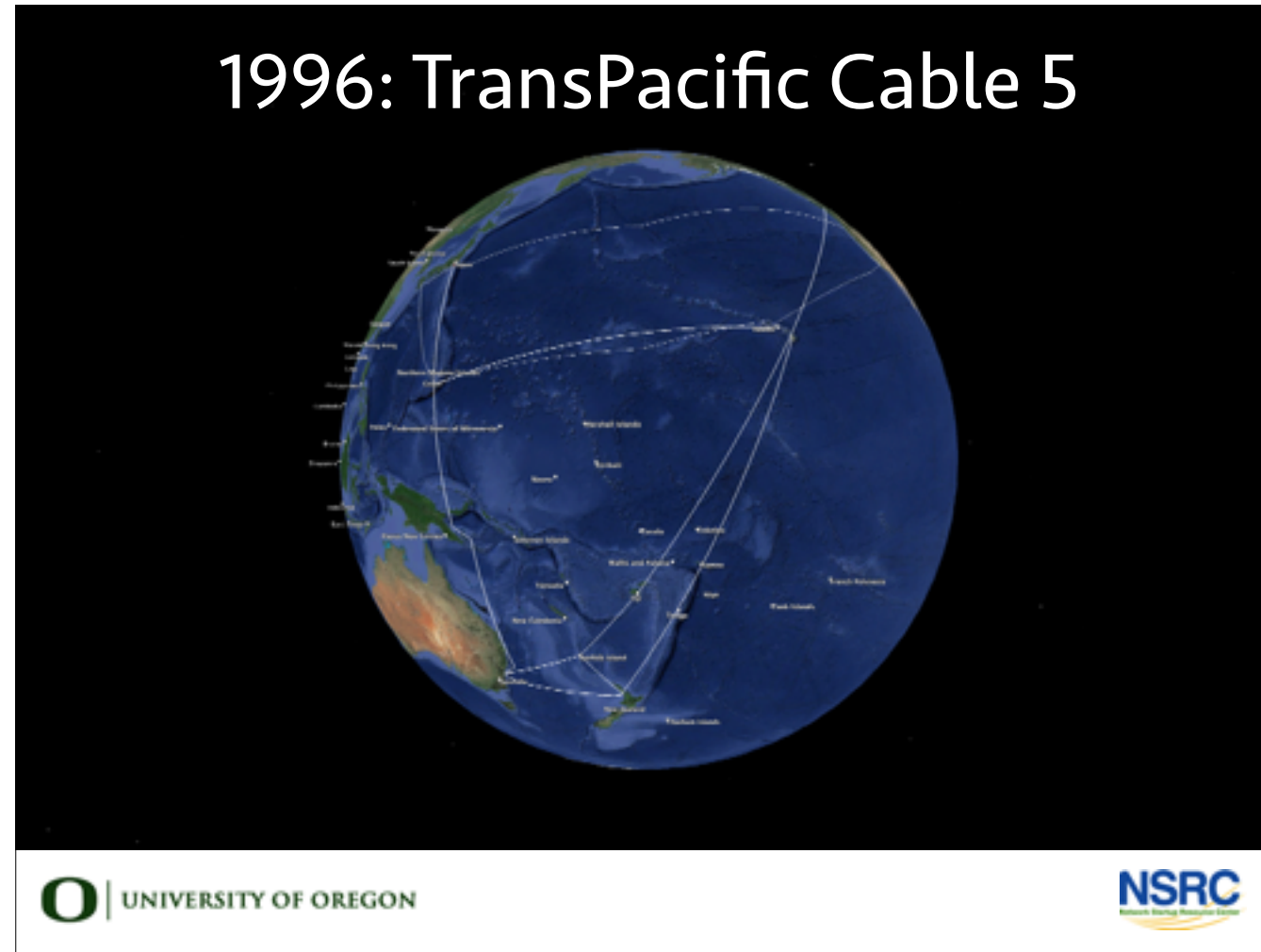


 UNIVERSITY OF OREGON

 NSRC

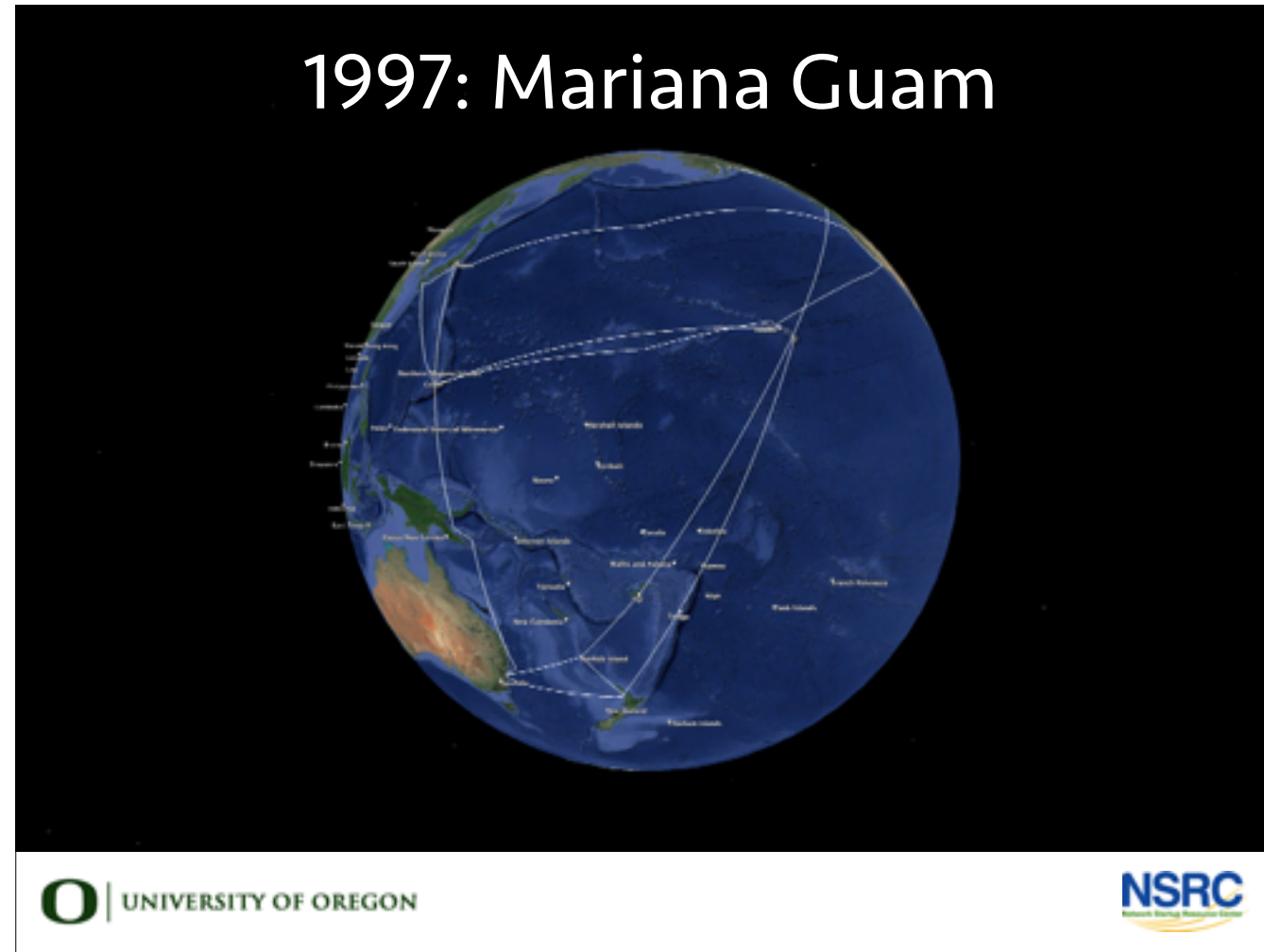
and PacRim West, joining Sydney to Guam, also at 560mbps. Not a lot of capacity, and as we'll see, these cables don't stick around all that long.

1996: TransPacific Cable 5



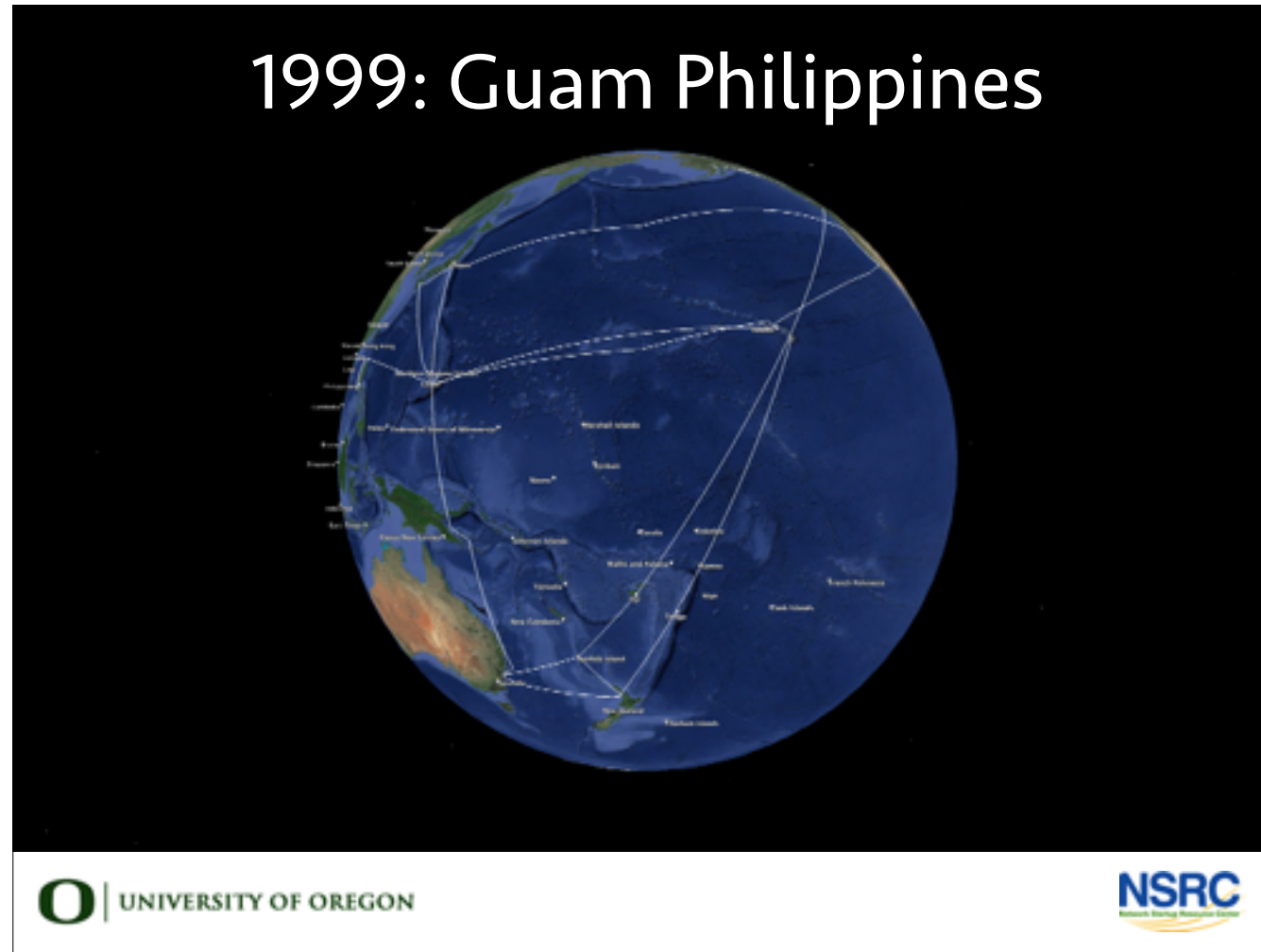
In 1996 TPC 5 lights up two pairs at 5gbps each in a loop connecting the US, Hawaii, Guam, and Japan. That's starting to sound like real capacity, at least for the 90s. Note Hawaii and Guam both starting to become important waypoints.

1997: Mariana Guam



1997 brings our first island hopper cable in the Pacific, the Mariana Guam cable. 240km long, three islands, and 6x 622mbps carriers. You're excused if you can't see the change on the map.

1999: Guam Philippines

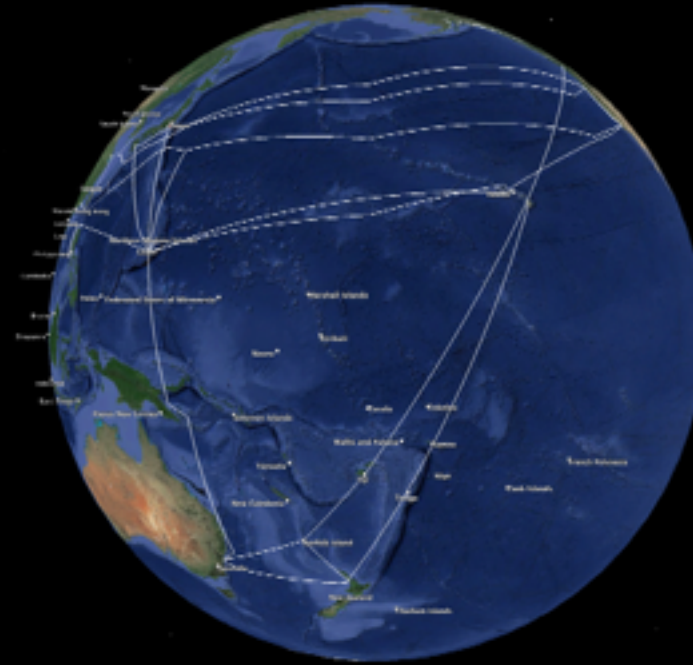


About the time Neil Stephenson was writing *Cryptonomicon* a brilliant piece of fiction about cryptography, submarine fibre, and data havens. Hitachi Cable was laying a 3600km cable between Guam and the Philippines.

We're just getting into dotcom boom times, and fibre laying is kicking into overtime. Guam - Philippines was only one of more than twenty submarine fibre cables laid in 99, but still, this cable cements Guam in its role as a major waypoint for submarine fibre in the Pacific. It's another step change in capacity too.

Remember just three years ago TPC5 lit a 10gbps ring from the US to Japan? Well Guam Philippines started life with 50 gbps of capacity, by way of 21 2.5gbps carriers.

2000: China US Cable

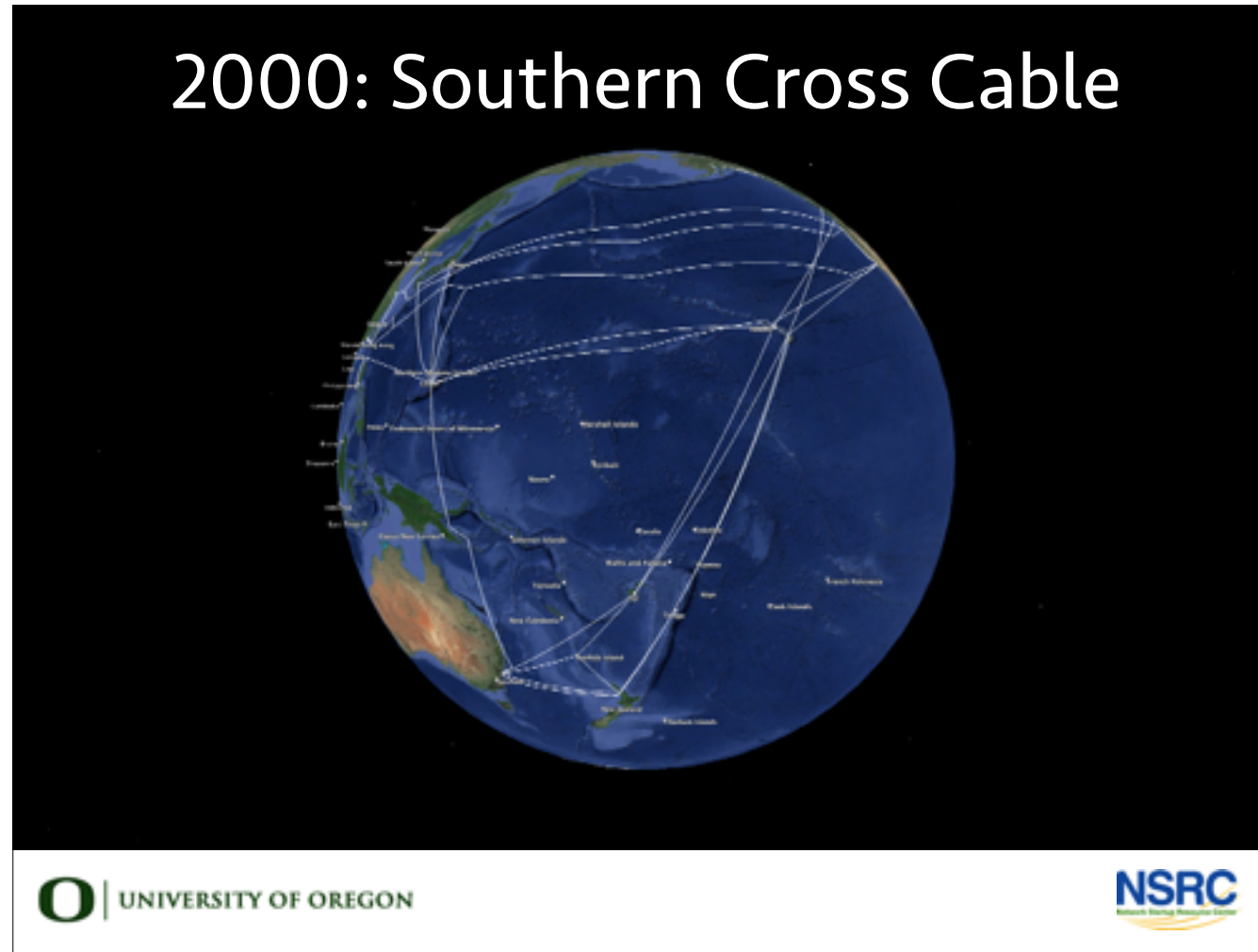


O UNIVERSITY OF OREGON

NSRC

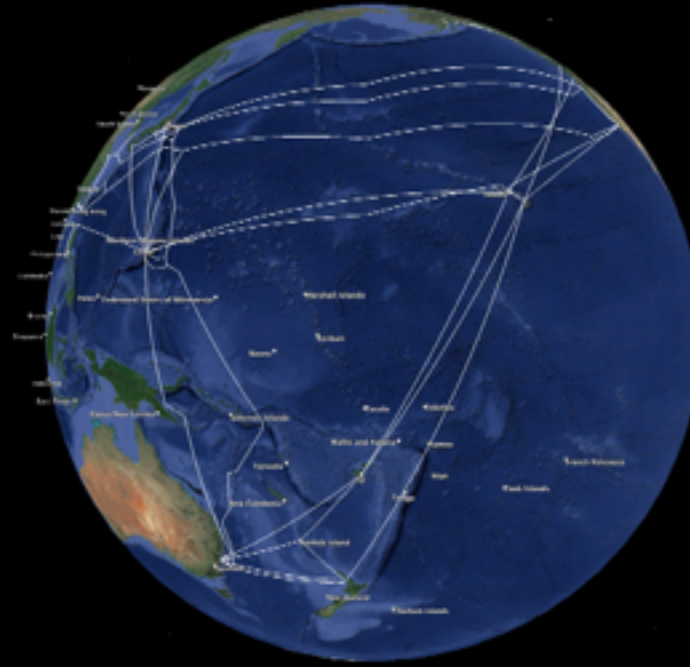
With Guam quickly becoming a hub, the China US cable drops 40gbps into Guam via a branching unit. As with Guam Philippines, Guam is now a destination, not just a waypoint.

2000: Southern Cross Cable



Finally New Zealand gets some love. Southern Cross is lit with 80gbps and a design capacity of 250gbps.

2001: Australia Japan Cable

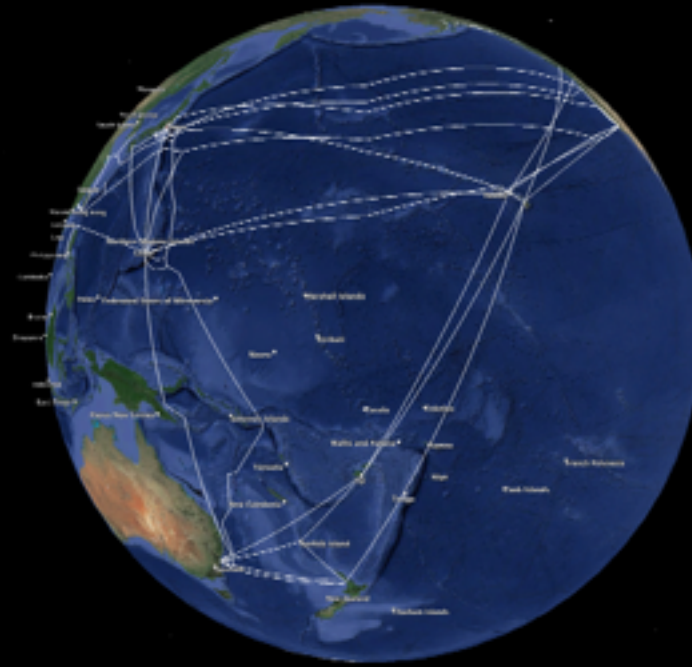


O UNIVERSITY OF OREGON

NSRC
National Science and Research Council

More for Guam with a 320gbps cable between Australia and Japan in 2001.

2001: Japan US Cable

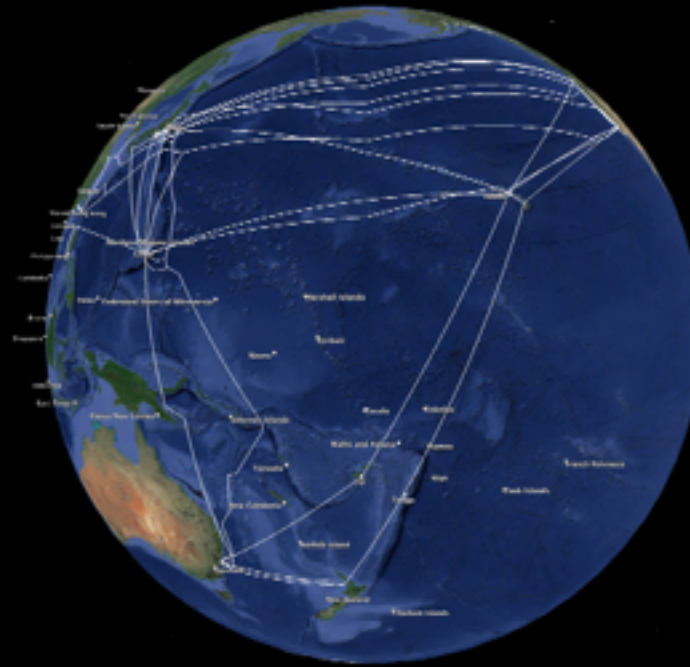


O UNIVERSITY OF OREGON

NSRC
National Science Foundation
National Science Research Center

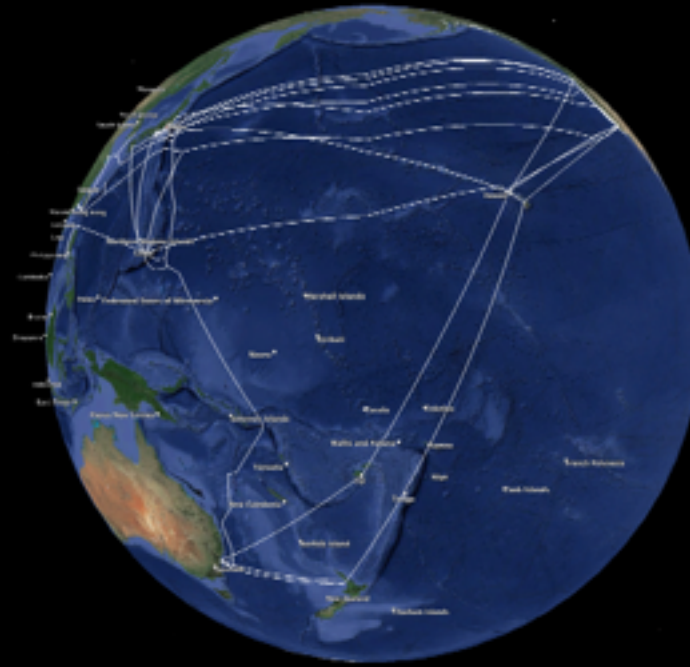
And a top-up for Hawaii in 2001, as a new cable from the US to Japan passes through with 320 gigabits per second. Hawaii now as busy as Guam with cables.

2002: VNSL Transpacific



2002 brings the decommissioning of ANZCAN and the introduction of VNSL Transpacific (now known as TGN Pacific), nominally a US Japan cable, but with a branch down to Guam to meet the rest of the world there. Design capacity of 5 terabits per second. Heady days for fibre.

2001-2005: -PacRim Cables

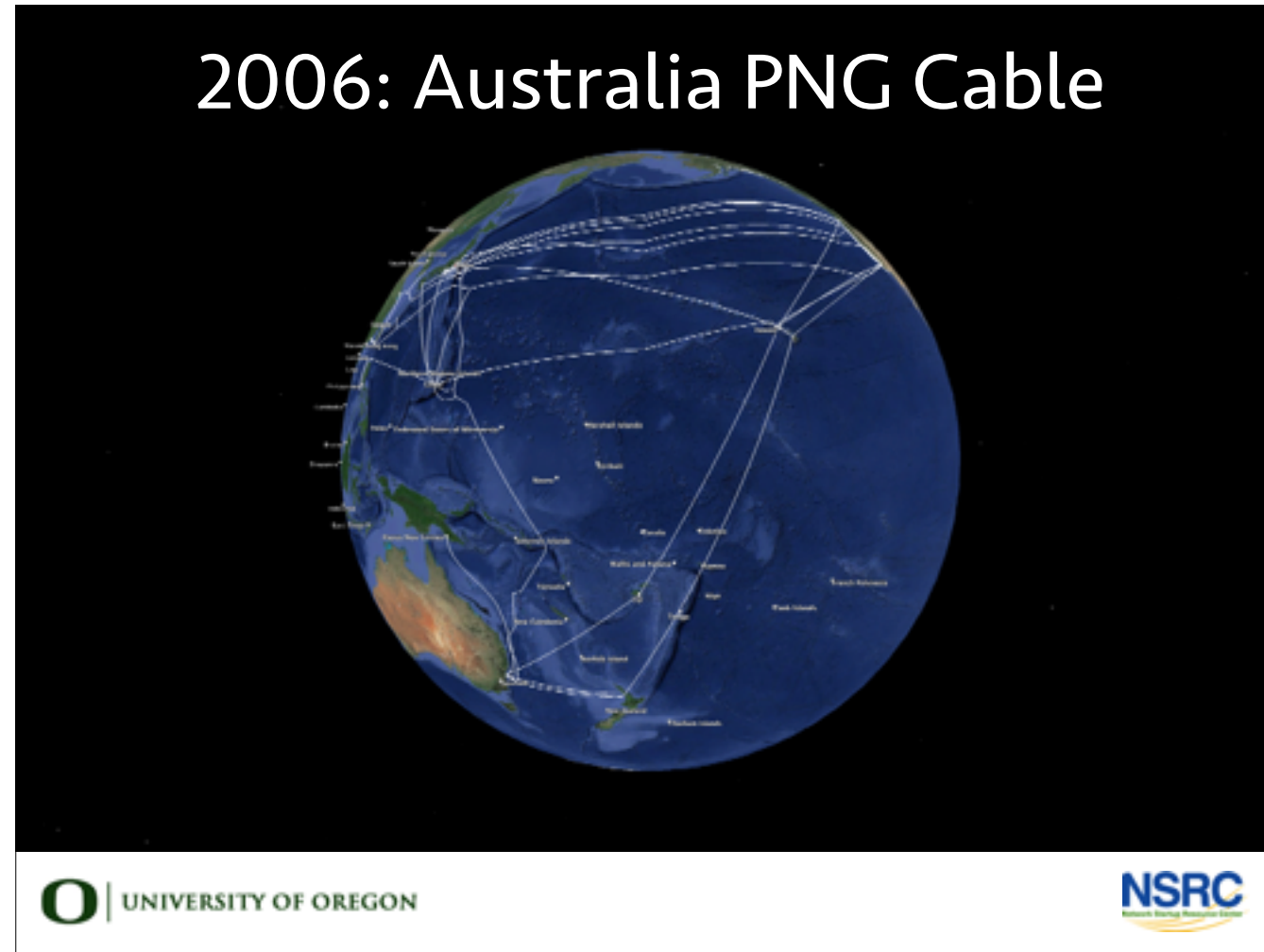


O UNIVERSITY OF OREGON

NSRC
National Science Foundation
Network Science Research Center

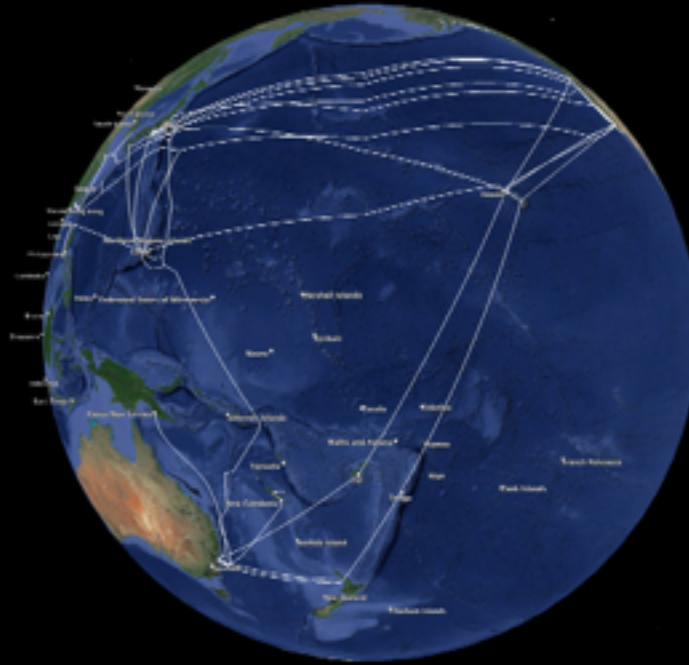
With their limited capacity, the short-lived PacRim cables are decommissioned - NZ to Hawaii in 2001, and Australia to Japan in 2005. But all is not lost.

2006: Australia PNG Cable



2006 has the cold, dead snake of PacRim West dragged off the seafloor and hauled to Port Moresby - recommissioned with a design bandwidth of just over a gigabit per second. From what I understand, regeneration in this cable is electronic, not optical, and E5 (565mbps) is as fast as electronic regeneration will work. So we've got two 565mbps bringing 1.1 gigabit per second into PNG.

2008: Gondwana



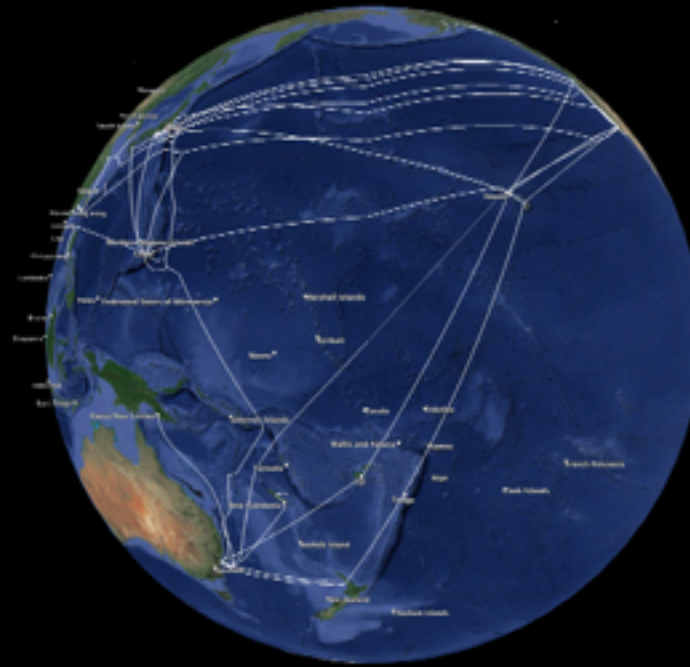
 UNIVERSITY OF OREGON

 NSRC

New Caledonia is the first major island infill project, with a new cable from Sydney lit at 20gbps in 2008. Likely taking advantage of idle Alcatel staff who would otherwise be waiting around to fix issues on Southern Cross.

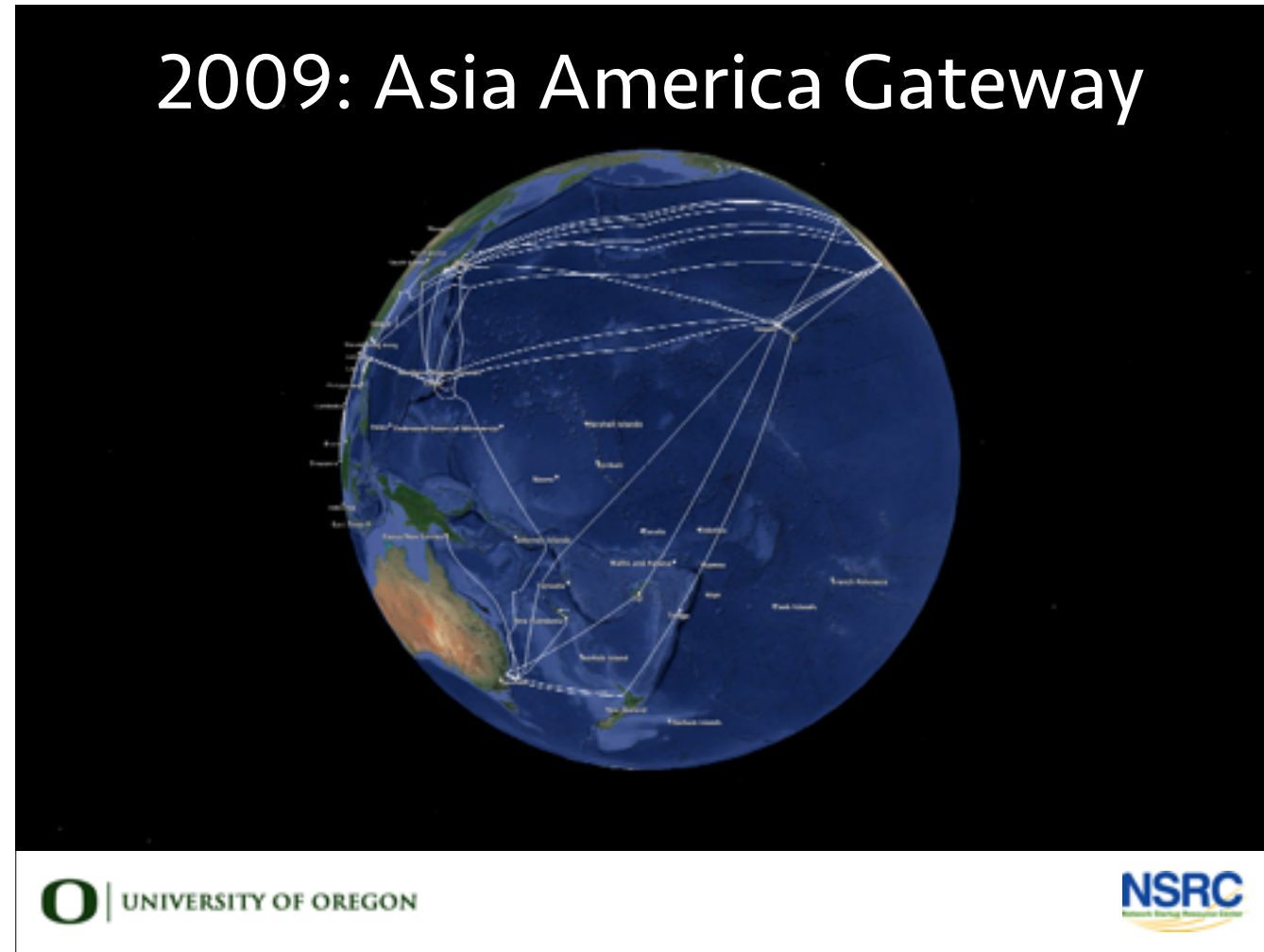
Just a couple more k and they'd have made it to Vanuatu, but that didn't happen..

2008: Telstra Endeavour



Also in 2008, Telstra lays a new cable directly from Sydney to Hawaii, bypassing Vanuatu, the Solomons, New Caledonia... You'd think they could have saved money combining efforts with Gondwana, but I guess not. They must have had a very specific goal in mind for their 1.28 terabit per second cable.

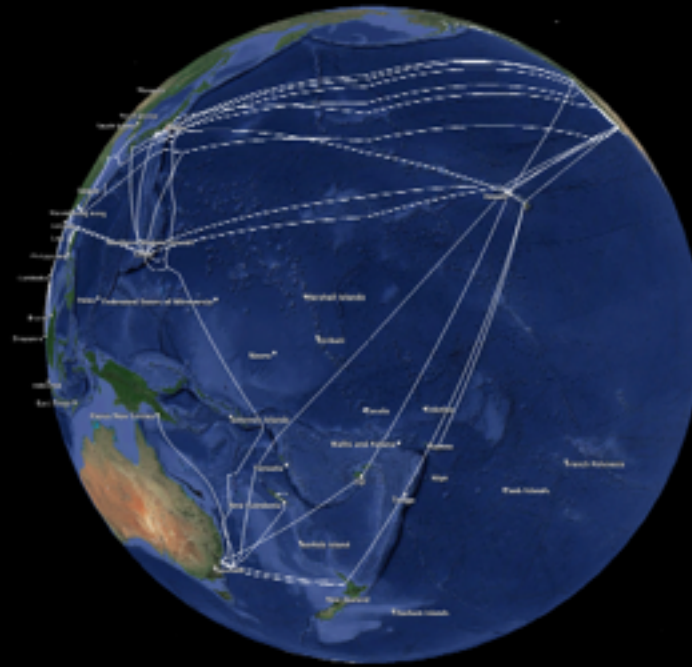
2009: Asia America Gateway



In 2009, we have the commissioning of the Asia America Gateway.

California, Hawaii, Guam, and then on to Asia. Initially half a terabit, but upgraded to 5 in 2011. At the same time , Tata's TGN Intra-Asia is installed from Singapore to Guam via Hong Kong and the Philippines. There's now an awful lot of bandwidth in and out of Guam.

2009: American Samoa Hawaii

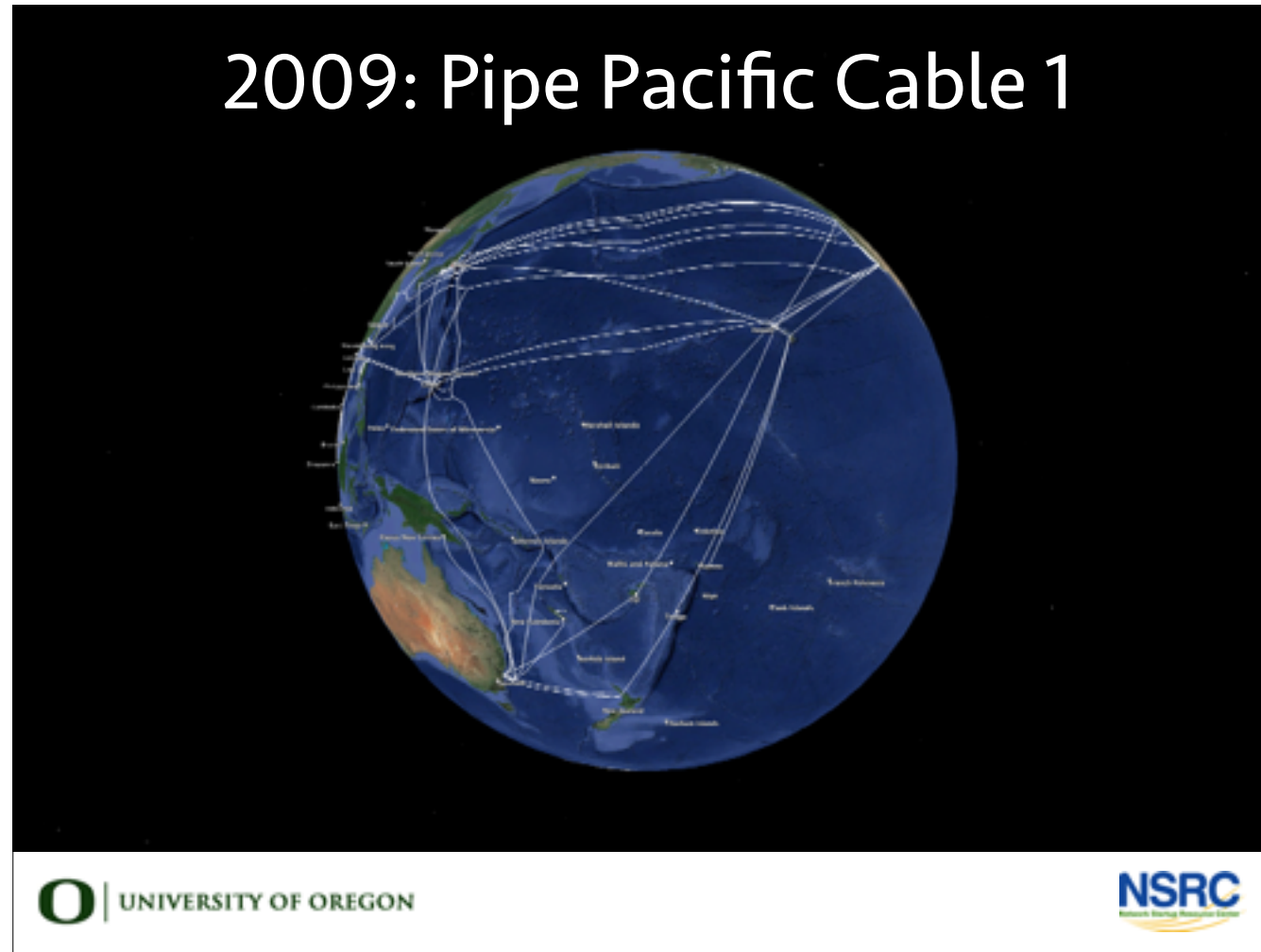


 UNIVERSITY OF OREGON

 NSRC

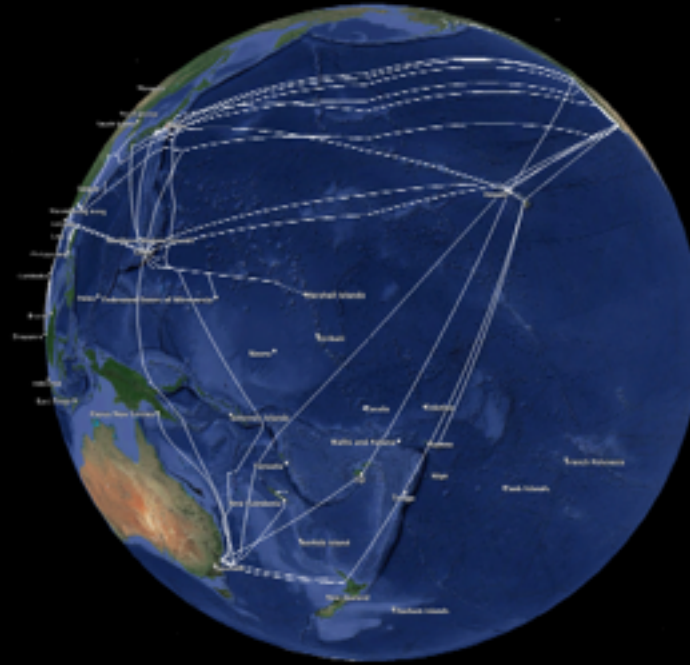
Also in 2009 we see another resurrection of the PacRim cable, this time the east section from Hawaii to Samoa. The cable is cut and hauled up to the Samoas and recommissioned at 1.1 gigabit per second as was done with PacRim West and Papua New Guinea. How much of that bandwidth is made available at an affordable price is a different matter.

2009: Pipe Pacific Cable 1



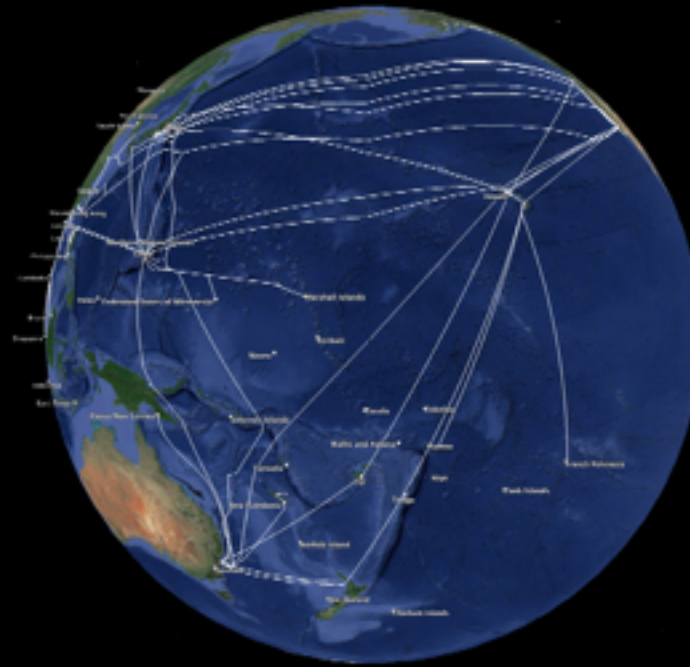
Rounding out 2009 we have Pipe's PPC1, which shot north to Guam (anyone surprised?) at 1.9 terabits per second with a branch to PNG, and potential for four more branches in between. Though the potential is there, the expense of taking the cable out of service for installation of a branch unit could be a deal breaker for anyone who wants to tap in. Branch units should really be installed before cables are commissioned.

2010: Hantru 1



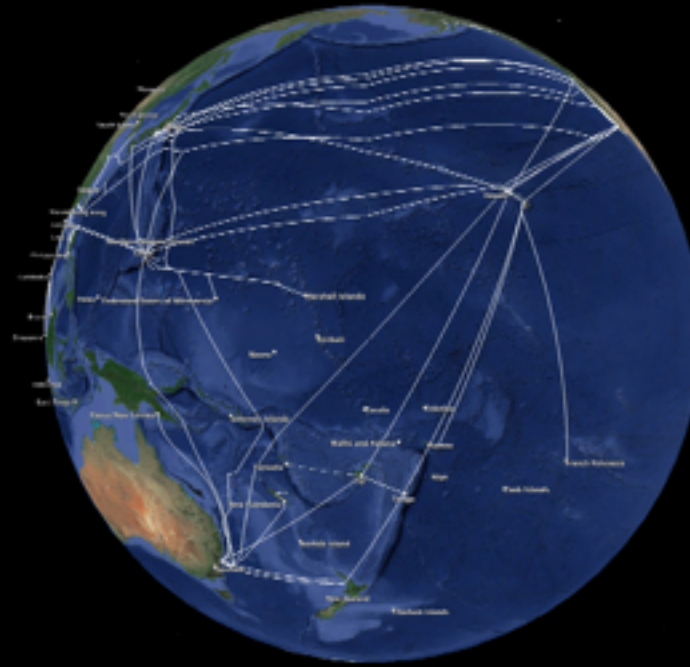
More Pacific infill comes about with a 20gbps cable linking Guam to Micronesia and the Marshall Islands. It's been reported this project relied on the US military as an anchor tenant.

2010: Honotua



And one more big Pacific project in 2010: Alcatel's 320gbps cable from Hawaii to French Polynesia. This is a big deal - if you remember from the last section of my presentation on distance, Tahiti is just about as far away as you can get from the rest of the world. Sure it was only lit with 20gbps, but that's not bad for a set of islands with a quarter million people on them.

2013-2014:Fiji, Tonga, Vanuatu

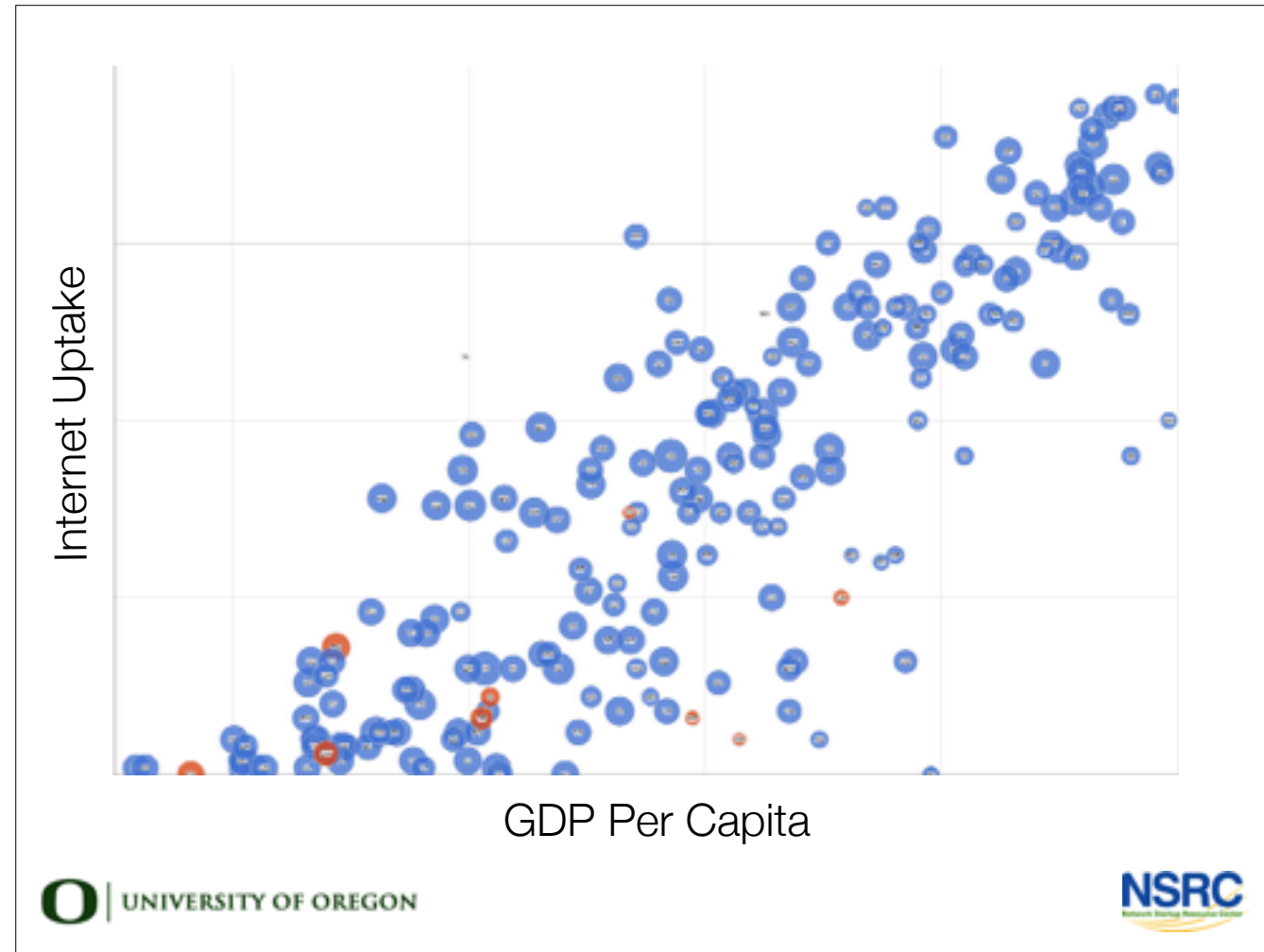


 UNIVERSITY OF OREGON

 NSRC

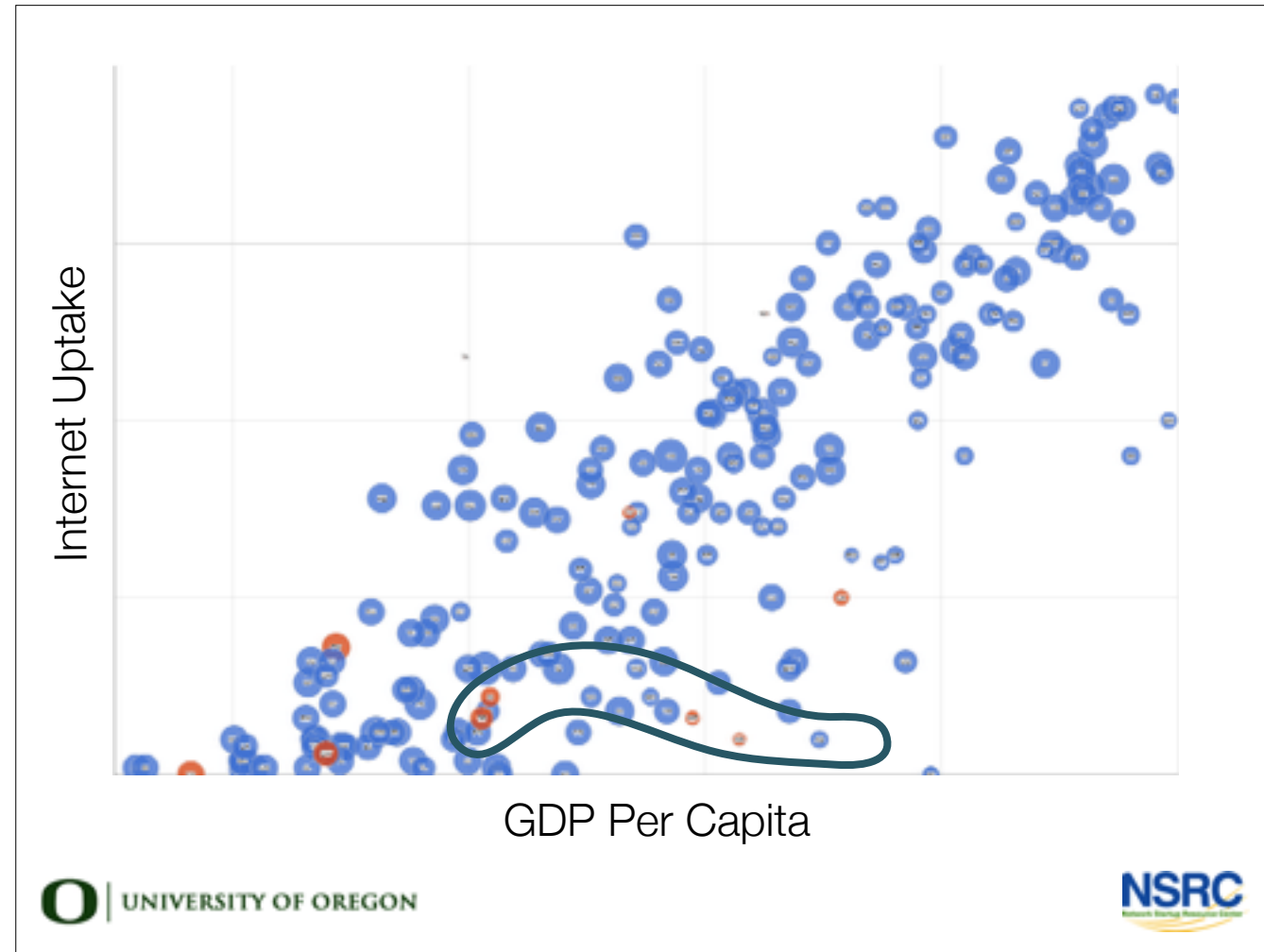
The last two years have seen two more small projects built by Alcatel Lucent Submarine Networks: the Tonga Suva cable in 2013, and the ICN cable from Vanuatu to Fiji in 2014. While both were lit at 20gbps, commercial arrangements are limiting use to the low hundreds of megabits on both.

So that's it for fibre in the Pacific. Now, does fibre access make a difference to Internet Uptake?



So back to our GDP per Capita vs. Internet Uptake, but this time, instead of colouring by distance, let's colour by access to fibre.

And it's hard to tell whether access to fibre makes a difference. There are only eleven countries in the world left without fibre. Eight of eleven are in the Pacific, but are generally so tiny they have no statistical significance.

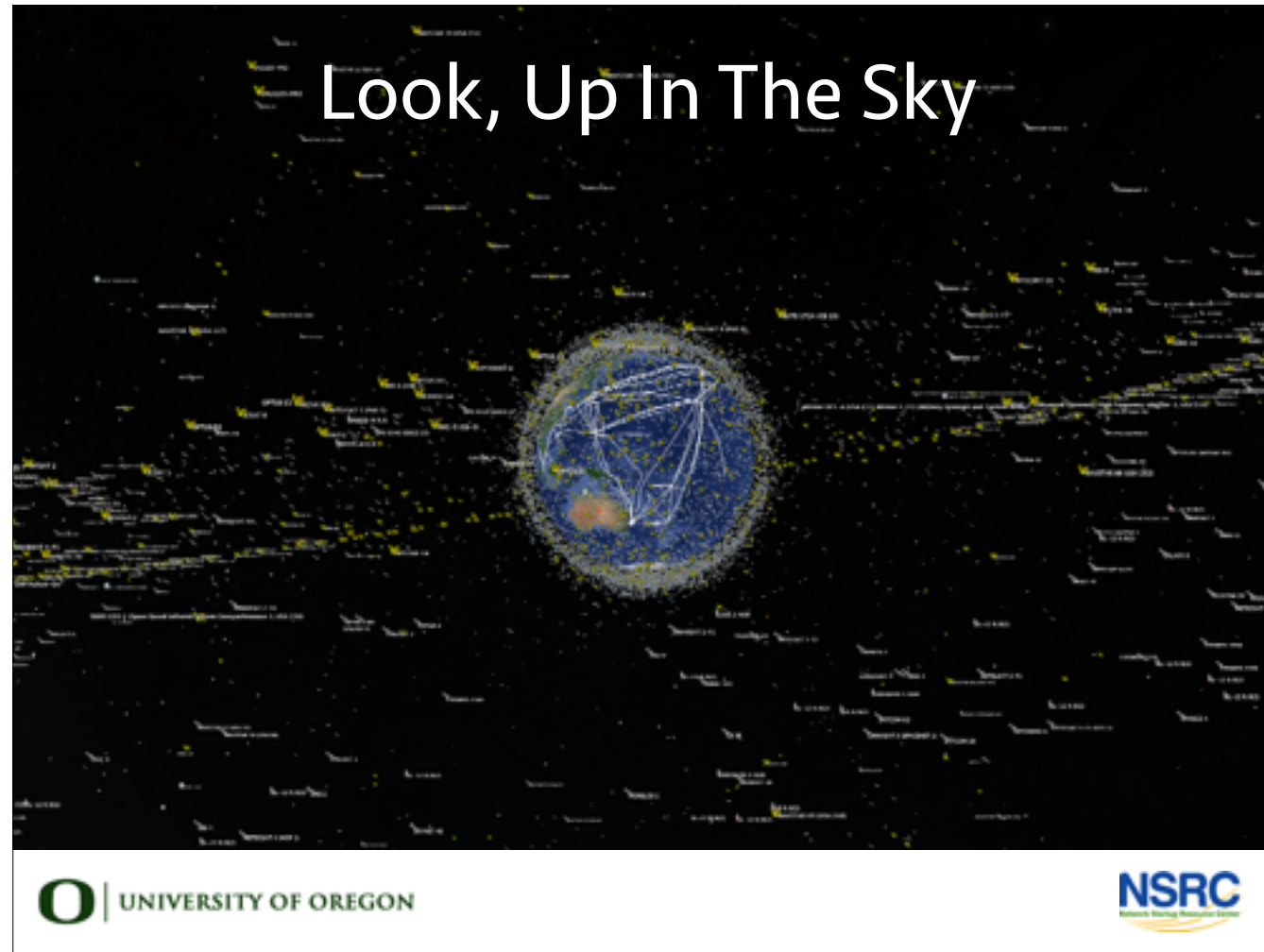


Of our little group of underachievers. Both American Samoa and Samoa are here, and they've had access to fibre since 2009. The Marshalls are here, and they've been online since 2010. Vanuatu has a good excuse, they've just been online a year - maybe things will change. But Papua New Guinea got its first fibre in 2006, and its second in 2009 and its Internet uptake is abysmal.

Also, there are countries here with no fibre, yet with much higher Internet use than some countries with fibre.

Maybe we should talk about satellite.

Look, Up In The Sky

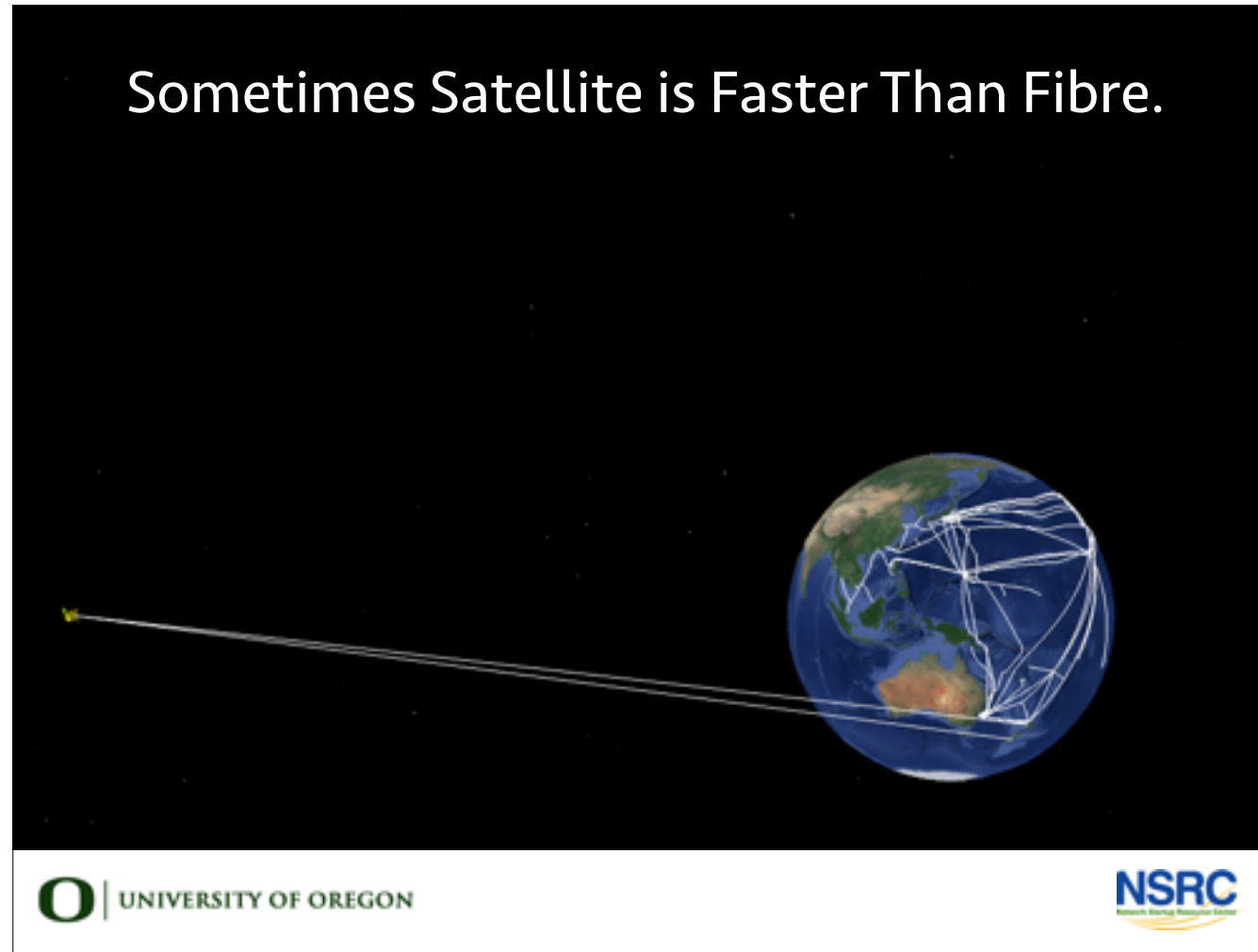


So the Cook Islands, who are a lot further away from the world than PNG, have higher Internet uptake.

And they're stuck with satellite. If stuck is the right word these days.

The map you see here is all the named, orbiting space objects, obtained via network link from a database called What's Up. There's a lot going on up there, and it's not all bad.

Sometimes Satellite is Faster Than Fibre.



O UNIVERSITY OF OREGON

NSRC
National Science and Research Council

Stuck with satellite isn't necessarily a bad thing. You see, sometimes satellite is faster than fibre.

Sometimes Satellite is Faster Than Fibre.

Satellite Math

- IPStar is 36,000 km Up
- $c = 300,000$ km /sec
- Albany Timaru RTT: 480ms



Let's do the math for IPStar, since most of us are familiar with it. By the way, this is a scale-accurate drawing of the path, if not the satellite itself.

This Isn't One Of Those Times

Fibre Math

- Albany to Timaru: 1240km
- $c = 200,000$ km /sec
- Albany Timaru RTT: 12.4ms



Note the speed of light inside glass is only $\frac{2}{3}$ the speed of light in a vacuum.

Right, I'm just having some fun here. But seriously.

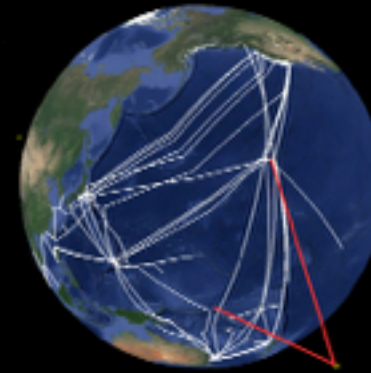
This Is One Of Those Times

Satellite Math

- O3b is 8,060 km Up
- $c = 300,000$ km /sec
- Honiara/Hawaii RTT: 107ms

Fibre Math

- Honiara/Hawaii: 11,150km
- $c = 200,000$ km /sec
- Honiara/Hawaii RTT: 111.5ms



O3B is a constellation of satellites in medium earth orbit, each with ten 1.2gbps spot beams, covering earth from the equator plus or minus 45 degrees. Again via the What's Up database, you're seeing all of O3b's constellation in on the slide here, exactly as they were positioned when I took a screen shot a few days ago. There are a dozen up there now, and the constellation can accommodate up to 120. That's 1.4 Terabits of potential coverage.

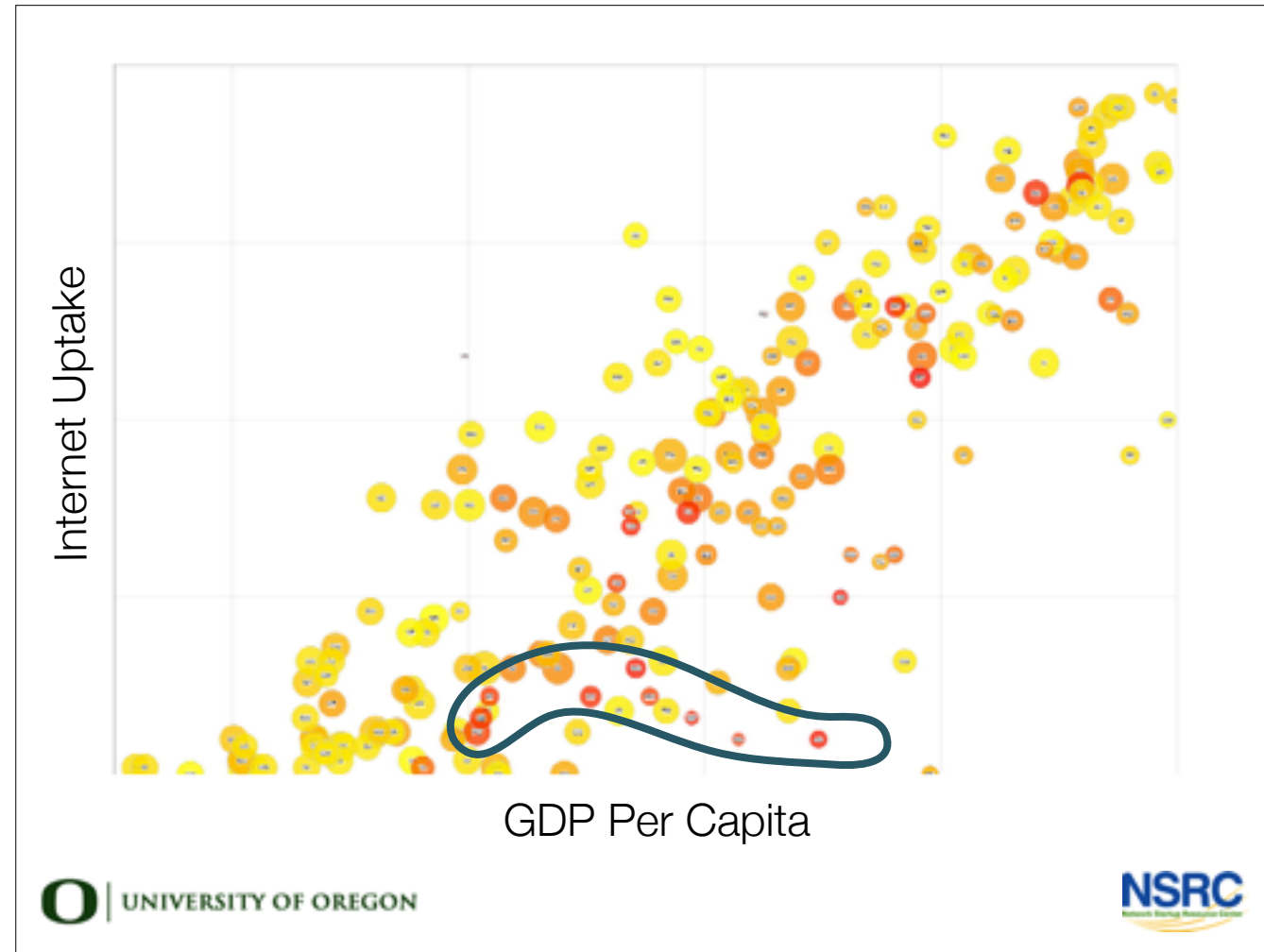
These birds orbit the earth pretty rapidly and subscribers need a pair of motorised tracking dishes to connect, so it's really suited best to telecommunications carriers.

Now it's really only 5,600 km from the Solomon Islands to Hawaii, but there's a story here.

Last month we had a chat with the CEO of Telekom Solomon Islands about his connectivity situation. At the moment he's got four different satellite bandwidth providers, and he's getting ready to bring on O3b as a fifth. At the same time, he's planning a fibre cable to Sydney. Apparently it's going to be cheaper than a branching unit to PPC1. Connections to Vanuatu or New Caledonia's new cables are not under consideration. Australia is where the Internet is, so Telekom Solomons want a cable to Australia.

When I told him performance to some parts of the world will be better on O3b than on his new fibre he didn't believe me. You can see here it's just a

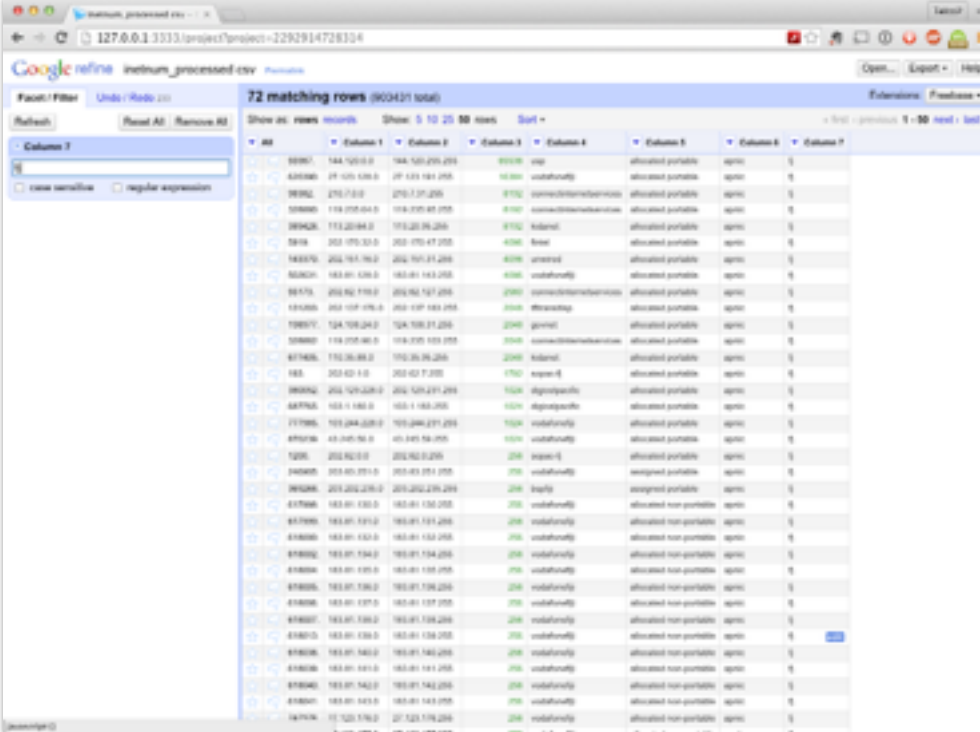
There's Heaps of Fibre
Satellite is now Awesome
(and getting even better)
What's the Problem?



We've still got these stragglers down here that should be performing far better than they are.

So I decided to investigate the price and performance of Internet across a few of these countries.

Carrier Investigation



#	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
50901	144.120.0.0	144.120.255.255	91000	usa	allocated portable	apnic
420000	24.125.128.0	24.125.191.255	14000	usathurup	allocated portable	apnic
91902	270.7.0.0	270.7.255.255	91902	comcastbusiness	allocated portable	apnic
509000	118.170.0.0	118.170.67.255	41907	comcastbusiness	allocated portable	apnic
919028	113.20.84.0	113.20.95.255	91902	idnet	allocated portable	apnic
50918	202.170.32.0	202.170.47.255	41908	frnet	allocated portable	apnic
143370	202.161.162.0	202.161.21.255	41909	gernet	allocated portable	apnic
603031	183.81.136.0	183.81.143.255	41910	usathurup	allocated portable	apnic
505715	202.92.710.0	202.92.727.255	21900	comcastbusiness	allocated portable	apnic
151000	202.107.176.0	202.107.193.255	41911	thetwinty	allocated portable	apnic
198977	124.100.242.0	124.100.251.255	21901	gernet	allocated portable	apnic
509000	118.170.0.0	118.170.103.255	21902	comcastbusiness	allocated portable	apnic
417406	110.36.88.0	110.36.95.255	21903	idnet	allocated portable	apnic
183	202.42.4.0	202.42.7.255	1790	usnet-0	allocated portable	apnic
900092	202.120.220.0	202.120.231.255	11204	algotipacific	allocated portable	apnic
487961	102.1.183.0	102.1.183.255	11205	algotipacific	allocated portable	apnic
717985	102.244.220.0	102.244.231.255	11206	usathurup	allocated portable	apnic
490106	41.245.56.0	41.245.59.255	11207	usathurup	allocated portable	apnic
1200	202.92.0.0	202.92.0.255	219	usnet-0	allocated portable	apnic
240000	202.001.271.0	202.001.271.255	219	usathurup	allocated portable	apnic
901004	202.202.216.0	202.202.216.255	219	usnet	allocated portable	apnic
437000	183.81.430.0	183.81.430.255	219	usathurup	allocated non-portable	apnic
437000	183.81.431.0	183.81.431.255	219	usathurup	allocated non-portable	apnic
430000	183.81.432.0	183.81.432.255	219	usathurup	allocated non-portable	apnic
430000	183.81.433.0	183.81.433.255	219	usathurup	allocated non-portable	apnic
430000	183.81.434.0	183.81.434.255	219	usathurup	allocated non-portable	apnic
430000	183.81.435.0	183.81.435.255	219	usathurup	allocated non-portable	apnic
430000	183.81.436.0	183.81.436.255	219	usathurup	allocated non-portable	apnic
430000	183.81.437.0	183.81.437.255	219	usathurup	allocated non-portable	apnic
430000	183.81.438.0	183.81.438.255	219	usathurup	allocated non-portable	apnic
430000	183.81.439.0	183.81.439.255	219	usathurup	allocated non-portable	apnic
430000	183.81.440.0	183.81.440.255	219	usathurup	allocated non-portable	apnic
430000	183.81.441.0	183.81.441.255	219	usathurup	allocated non-portable	apnic
430000	183.81.442.0	183.81.442.255	219	usathurup	allocated non-portable	apnic
430000	183.81.443.0	183.81.443.255	219	usathurup	allocated non-portable	apnic
147004	11.120.716.0	11.120.716.255	219	usathurup	allocated non-portable	apnic

To find Pacific carriers, I requested raw data access to APNIC's whois database, and imported into a data mining tool called OpenRefine.

I then trolled for allocations of greater than a /24 across each of the countries in the Pacific. Of course that means I missed a few - for example one in American Samoa that has an allocation from ARIN, not APNIC.

Price Investigation

The screenshot shows the Blue Sky Moana website. The header includes the Blue Sky logo and navigation links: Personal, Business, MoanaTV, Directory Services, Tools, News & Offers, Company Info, Jobs, and Contact Us. A large banner features the 'moana' logo and a woman's face. Below the banner, there are sections for 'Rates & Plans' and 'iPhone 4S'. The 'Rates & Plans' section includes a table for Residential Broadband and MoanaTV Cable High Speed Broadband Internet.

Plan	Monthly	2 Year Contract	3 Year Contract
Broadband Wireless Internet (7Mbps)	\$99.00	\$175.00	\$200.00
Broadband Wireless Internet (10Mbps)	\$119.00	\$200.00	\$225.00

Installation is a one time fee of \$150.00

Plan	Cable	Internet	Monthly Total
Broadband Gold (7Mbps)	\$45.99	\$70.00	\$115.99
Broadband Platinum (10Mbps)	\$45.99	\$105.00	\$150.99

Installation is a one time fee of \$150.00

Then I did some web surfing & some note taking for prices.

Performance Investigation



On the performance front, I spun up VMs around the world and pointed 360 probes at 45 Pacific networks. I was interested to see in general how telcos in the Pacific were performing latency-wise, and whether poor routing or peering practices might be hurting performance. I then put some of my distance calculations to use again as you'll see in a moment.

American Samoa

 UNIVERSITY OF OREGON

 NSRC

Right, so back to the Islands. I'll go through a few examples, and one or two carriers per island.

BlueSky Samoa

- HFC, Wireless, Cellular Operator
- Same Parent as ASH Cable
- Competes against ASH Customers
- ASH FY13 = US \$5.8m (800mbps at \$600/mbps)
- 768kbps Cable Subscribers Pay US \$70/month



Right here we've got a potential answer for why American Samoa has such expensive Internet, and why uptake is so low. We've got a limited capacity cable, expensive rates on it, and demand to support prices that are actually more expensive than some satellite Internet services. That was pretty easy. Let's look at performance.

BlueSky Performance

Location	Distance	Best RTT	Actual RTT	Ratio
Tokyo	7,617	76.17	240	3.15
Singapore	9,552	95.52	300	3.14
Sydney	4,397	43.97	270	6.14
Ireland	15,435	154.35	280	1.81
Sao Paulo	12,613	126.13	290	2.30
North Virginia	11,330	113.3	190	1.68
Oregon	8212	82.12	140	1.70
Hawaii	4144	41.44	60	1.45
Overall Performance Indicator:				2.67



Actual ping times are not so hot. Hawaii is about right, but the rest of Asia looks pretty sad. In particular, Sydney. Look at that mess. It's pretty obvious BlueSky's upstream heads straight to North America.

Anyway, moving on to Nauru.

Nauru



 UNIVERSITY OF OREGON

 NSRC

10,000 permanent residents and some unknown number of guests of the Australian government reside on Nauru. I hear from one of my colleagues that Nauru's ISP is experiencing some issues and may not be installing new circuits, so we'll skip the commercial bits and just move onto performance.

CenPacNet Nauru

Location	Distance	Best RTT	Actual RTT	Ratio
Tokyo	5,042	50.42	823	16.32
Singapore	7,016	70.16	740	10.55
Sydney	4,051	40.51	628	15.50
Ireland	14,134	141.34	930	6.58
Sao Paulo	15,500	155	981	6.33
North Virginia	12,258	122.58	851	6.94
Oregon	8650	86.5	816	9.43
Hawaii	4669	46.69	838	17.95
Overall Performance Indicator:				11.20



We already know Nauru is on Satellite - and by this table it looks like it's coming from Sydney. It also appears its routes to Hawaii take the long way around, via Asia or more likely the West Coast of the US.

Marshall Islands



Since the commissioning of their new cable, the Marshalls Islands Telecommunications Authority have been keen to improve Internet connectivity and uptake, and given the amount of bandwidth they have into Guam, I see that happening pretty quick.

MINTA

- MINTA: Marshall Islands National Telecoms Authority
 - 1gbps on Hantru-1, /22 from APNIC
 - Fibre + Wireless “Ring” Backbone
 - GeoStationary Satellite or Wireless to Some Islands
 - 512kbps ADSL Subscribers Pay US \$70/month



Connectivity is still very expensive for the locals, but performance should be pretty good given their proximity to Guam. Let's see.

MINTA Performance

Location	Distance	Best RTT	Actual RTT	Ratio
Tokyo	4,646	46.46	69	1.49
Singapore	7,487	74.87	146	1.95
Sydney	5,018	50.18	168	3.35
Ireland	13,304	133.04	336	2.53
Sao Paulo	15,579	155.79	353	2.27
North Virginia	11,340	113.4	238	2.10
Oregon	7717	77.17	197	2.55
Hawaii	3850	38.5	219	5.69
Overall Performance Indicator:				2.74



In general MINTA looks good, but the loser here is Hawaii. A traceroute confirms that despite Hawaii Guam being the biggest cable route in the Pacific, traffic here is routing Hawaii, Los Angeles, Tokyo, Guam, then on to the Marshall Islands. Sydney also routes via Tokyo, most likely shooting straight through Guam on the way.

Why is Internet Uptake so low in the Marshalls? You saw the price. At least the performance is pretty good.

Vanuatu



Vanuatu is a real interesting case. There's a new cable, and the Internet market is getting competitive, but backhaul is still very expensive.

Telsat

- Sub-155mbps on ICN cable @ \$600/month
- Upstream via Fibre is same \$\$ as via VSAT
- Shifting Contracted VSAT Capacity to In-Country Links
- Peers at VIX & Gets Free CDN
- 512kbps Wireless Subscribers Pay US \$35/month



It's just a matter of time before Vanuatu lifts its Internet penetration given the products on the market now since last year's cable installation.

Note the entry level broadband price - it's half what you'd pay in American Samoa, yet their international bandwidth costs are the same.

Telsat Performance

Location	Distance	Best RTT	Actual RTT	Ratio
Tokyo	6,370	63.7	251	3.94
Singapore	7189	71.89	170	2.36
Sydney	2596	25.96	59	2.27
Ireland	15,783	157.83	363	2.30
Sao Paulo	14369	143.69	415	2.89
North Virginia	13325	133.25	280	2.10
Oregon	9854	98.54	249	2.53
Hawaii	5676	56.76	274	4.83
Overall Performance Indicator:				2.90



Telsat's performance looks ok but given their fibre path to Fiji, which could head straight on to Hawaii and Oregon, it seems there are some issues - namely all their traffic is heading to Sydney first.

Cook Islands



Technically the Cook Islands is outside of our interest area, with internet uptake of 25%. But we've seen some fibre performance and some standard satellite performance, and I'd like to see some O3b performance.

Telecom Cook Islands

- 2G/3G Mobile Provider
- Wi-Fi Hotspots for Pre-paid Internet
- ADSL2 for Post-Paid Internet
- Launch Customer for O3b
- NZ \$50 for 1.25GB Wi-Fi
- NZ \$50 for 3.5GB ADSL2



Internet isn't cheap here, but it's not too expensive either. The Cook Islands have a much higher GDP per capita than some of their neighbours.

Cook Islands Performance

Location	Distance	Best RTT	Actual RTT	Ratio
Tokyo	8,986	89.86	528	5.88
Singapore	10,738	107.38	522	4.86
Sydney	4,989	49.89	432	8.66
Ireland	15,717	157.17	593	3.77
Sao Paulo	11,246	112.46	632	5.62
North Virginia	10,877	108.77	497	4.57
Oregon	8272	82.72	471	5.69
Hawaii	4600	46	437	9.50
Overall Performance Indicator:				6.07



So how's O3b working out for them? Keep in mind, Rarotonga is as far away as it gets.

It's not. Our math says it should be 107ms RTT. Back in November, Matthew Harrison from Primo posted a traceroute from the Cooks to NZ, showing latency to Hawaii at 122ms, so we know O3b works.

I can only assume Cooks are favouring their PacTel transit at the moment, via a satellite 30,000 kilometers up in the air.

Solomon Islands



NSRC was in the Solomons last month for PacNOG 16. It was an interesting experience.

Solomons Telekom

- Our Telekom ADSL & Wi-Fi
 - Four Satellite Carriers - Soon to be Five with O3b
 - Nokia DSLAMs, Huawei 3G RAN, Ruckus Wi-Fi
 - Resell Speedcast VSAT that doesn't touch their core
 - Wi-Fi Pre-Pay US \$35 per 250mb
 - Mobile even more expensive.



Of all the Pacific countries, only Papua New Guinea is poorer. And yet, the incumbent carrier has some seriously fancy equipment, and prices to match. With a GDP per capita of \$91/month, it's probably not the locals who are paying US \$140 gig for Wi-Fi.

Is there performance to match the price?

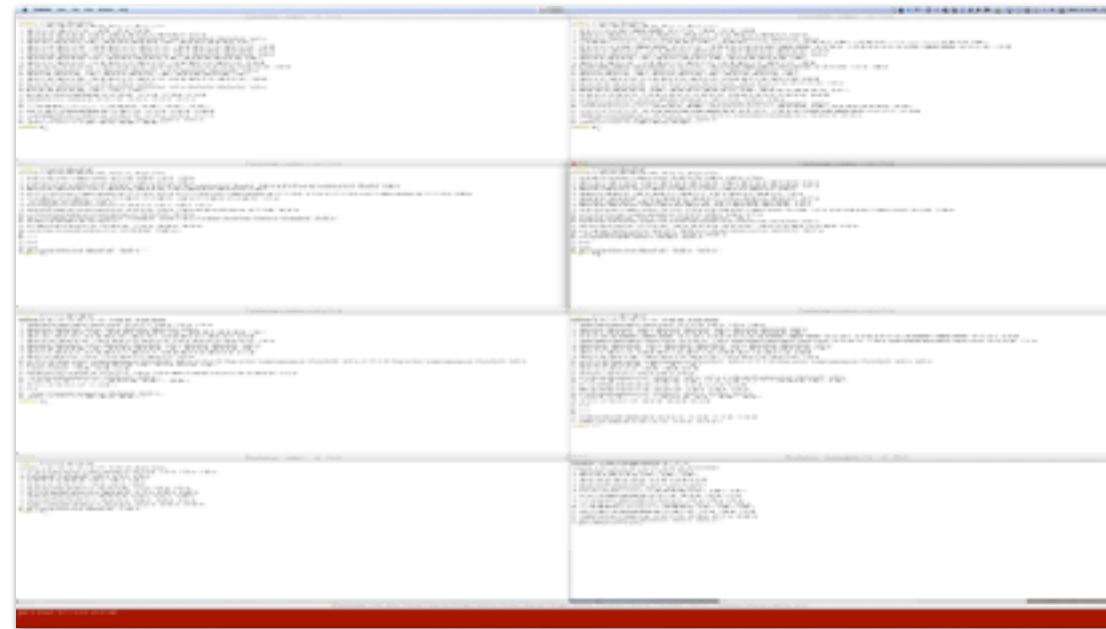
Our Telekom Performance

Location	Distance	Best RTT	Actual RTT	Ratio
Tokyo	5,455	54.55	685	12.56
Singapore	6,337	63.37	742	11.71
Sydney	2,863	28.63	643	22.46
Ireland	15,029	150.29	774	5.15
Sao Paulo	15,363	153.63	800	5.21
North Virginia	13,515	135.15	651	4.82
Oregon	9,915	99.15	683	6.89
Hawaii	5,865	58.65	656	11.18
Overall Performance Indicator:				10.00



Our Telekom's performance is anomalous when it comes to Pacific carriers. Ok, it's obvious they're on satellite, so latency isn't so hot. But it's also obvious they're doing something right.

Some Traceroutes



I had a look at the paths from all my probes from the world to Telekom Solomons.

Our Telekom Performance

Location	Distance	Best RTT	Actual RTT	Ratio
Tokyo	5,455	54.55	685	12.56
Singapore	6,337	63.37	742	11.71
Sydney	2,863	28.63	643	22.46
Ireland	15,029	150.29	774	5.15
Sao Paulo	15,363	153.63	800	5.21
North Virginia	13,515	135.15	651	4.82
Oregon	9,915	99.15	683	6.89
Hawaii	5,865	58.65	656	11.18
Overall Performance Indicator:				10.00



From Tokyo to the Solomons: Osaka to Sydney, then up in the air via Global Gateway.

Singapore first goes via Tokyo then Sydney, so it could be better.

Both should be going via Telekom's SES in Hong Kong, but for some reason they're not.

Sydney of course heads straight up and down via Global Gateway.

North Virginia transits via the west coast, appearing to head up in the air from IntelSat

Oregon and Hawaii both head up in the air from Hawaii via PacTel.

If you have to be on geostationary satellite, Solomons Telekom haven't done a bad job of it.



Telekom Solomons isn't the only carrier in the Solomons relying on satellite.

BeMobile Performance

Location	Distance	Best RTT	Actual RTT	Ratio
Tokyo	5,455	54.55	608	11.15
Singapore	6,337	63.37	671	10.59
Sydney	2,863	28.63	664	23.19
Ireland	15,029	150.29	833	5.54
Sao Paulo	15,363	153.63	863	5.62
North Virginia	13,515	135.15	771	5.70
Oregon	9,915	99.15	702	7.08
Hawaii	5,865	58.65	714	12.17
Overall Performance Indicator:				10.13



BeMobile is Vodafone's Affiliate in the Solomons. No pricing on their website - for data, if you have to ask, you probably can't afford it. It was easy enough to have a look at their performance though.

They've had a different strategy for satellite. Just one ground station, but in Guam, via Telecom Marshall Islands. As we know from our cable routes earlier in the presentation, Guam is spectacularly well connected. As a result, performance across the board is quite similar to Our Telekom even with their complex strategy of distributed teleports.

Papua New Guinea



Digicel PNG

- 2G/3G Carrier
- Pre and Post-Paid Cellular Voice and Data
- US \$35 for 1.6GB mobile data



PNG, for being the poorest country in the Pacific, actually has a competitive telecommunications market. It's not cheap, but it's better than many.

Digicel PNG

Location	Distance	Best RTT	Actual RTT	Ratio
Tokyo	5,085	50.85	264	5.19
Singapore	4,955	49.55	181	3.65
Sydney	2,750	27.5	60	2.18
Ireland	14,671	146.71	354	2.41
Sao Paulo	16,069	160.69	391	2.43
North Virginia	14,559	145.59	278	1.91
Oregon	10,926	109.26	248	2.27
Hawaii	7,069	70.69	250	3.54
Overall Performance Indicator:				2.95



From the looks of it, Digicel are on PPC1, but only transit via Australia and don't announce in Hawaii. I see Hawaiian traffic heading to Los Angeles before its trip to Australia. Even worse it appears traffic from Tokyo passes through Singapore on its way to Australia, then back to PNG.

Pacific Interconnectivity



For time we're going to wrap up with those few examples - though there's a lot more data and there are a lot more stories and situations to discuss.

Now for a minute on peering & interconnectivity, as we've had some great examples in the last few countries.

Pacific Interconnectivity

- Focus on Transit to the nearest big market(s)
- No regard for other Pacific Island countries
 - Vanuatu -> Suva traffic routes via Australia
- Typically no peering or even paid interconnections
- In PNG two carriers take two different fibres out
- Vanuatu Exchange works - due to government help



Island Interconnectivity is a disaster. The probes I set up look in from the world at the Pacific, but the real interesting issues have to do with why the Pacific doesn't talk to itself, and whether that may help those countries with low Internet adoption increase their use.

Potential Next Steps

- Document Pacific Economic, Social, & Educational Ties
- Monitor Interconnectivity from ~ 60 Pacific networks
- Determine Regional Routing Inefficiencies
- Analyse Benefits of Regional Peering Points
 - Does every country need an exchange? Maybe not.
- Develop a Strategy for Improving Interconnectivity



This is my wrap-up for now. I've proposed a project to distribute Smokeping and traceroute probes into networks throughout the Pacific so we can get a good picture at what's going on. Depending on what kind of cooperation I get, I may even look for some netflow data to get a picture of volume of inter-Pacific traffic - it happens I've already helped a number of Pacific network admins do traffic analysis at PacNOG workshops, so I am hopeful.

Thank you all for your time, and feel free to talk to me about this work, PacNOG, or NSRC at any time.