# planet.

#### 88 Satellite Deployment and Frequency Licensing for Planet's Earth Imaging Constellation

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#### Launch

- Launched 88 Dove Satellites on PSLV-C37 (Cartosat-2D)
  - 15 Feb 2017 UTC
  - Total 104 satellites, 101 CubeSats, 25 QuadPacks
  - Everything went really smoothly
  - Not the first time QuadPacks were launched on PSLV
  - Sequencer needed to be built and tested
  - Extra QuadPacks supported another 20 satellites
- Pathfinder: PSLV-C34
  - 12 Doves deployed on 22 June 2016
  - This launched proved that Planet, ISIS, and ISRO/Antrix knew how to handle large amounts of satellites

Disclaimer: I am not a lawyer. I am not intending to provide legal advice or counseling, and the audience should seek their own counsel.







#### Valentine's Day Launch

100VE

YOU SPIN MY WHEELS

Credit: ISRO

I'M CRAZ









## **Commissioning Status**

- All satellites contacted and health data downloaded 3 hours after launch (second pass)
- Upload 3 MBytes of software updates
- Status as of April 20th:
  - 40 fully commissioned and imaging
  - 46 undergoing commissioning
  - 2 non-responsive (expected 5%)
  - Expect commissioning complete in June 2017
  - Non-overlapping ground tracks in June 2017
  - Not fully phased until Oct 2017
- Total satellite fleet (April 20th):
  - 84 imaging from all launches





#### **Ground Station Status**

- Up to 16 S/X-band dishes, 31 UHF systems
- Latest launch brings us well over 2 TB/day
- 180 Mbps average, 220 Mbps max (limited by USB)
- ISS dropouts due to Beta-min (low power & no land)







## **CubeSat Licensing**

- The first 15 CubeSats (launched 2003-2007) used amateur radio frequencies, even "commercial" and NASA sats
- IARU coordinated these sats, because coordination prevents interference
- The FCC released "Guidance on Obtaining Licenses for Small Satellites," <u>DA-13-445</u> in May 2013
  - Detailed experimentally licensed sats on amateur frequencies with IARU blessing
- In 2016, IARU has started to decline coordination for non-amateur satellites
  - Too many satellites, not enough spectrum
  - Sats that don't comply with RR 1.56
  - If not IARU coordinated, FCC won't provide license





## **Amateur Licensing Process**

- "<u>A Survey of CubeSat Communication Systems:</u> 2009-2012," presented at this workshop in April 2013
- Amateur process not applicable to Planet Labs; we are a commercial company





## Not Amateur, Where to go?

- Determine which service you fit into
  - Earth-Exploration satellite service
  - Space Research service
  - Inter-satellite service
  - Land mobile-satellite service
  - Meteorological-satellite service
  - Space operation service
- "Lots" of spectrum available
  - Look in NTIA Red Book
  - FCC Table of Allocations
- <u>http://www.itu.int/en/ITU-R/space/workshops/2016-</u> small-sat/Documents/04-AM-ART5.pdf





## **Two Options for FCC Licensing**

- Test our your system with Part 5 Experimental license
  - License to test out new hardware and modes
  - No protection from existing users
- Transition to a real Part 25 Satellite Service license
  - Protection from existing services
  - Timeline designed for decade-long missions
- All FCC interactions are public, posted on web





## **Part 5 Experimental License**

- Intended to test out new technologies related to radio: experimentation, product development, and market trials
- Frequency selection:
  - Respect the Table of Allocations
  - Pick one you will use for the long term
- Quick turnaround; licenses usually granted in 3-6 months
- Up to 5 years in length
- \$70 total
- Launch integrator might do this for you
- Secondary usage of spectrum
  - No protection from interference
  - Must cease all transmission if interference is caused to primary users





#### **Experimental License Search**

<u>https://apps.fcc.gov/oetcf/els/reports/GenericSearch.cfm</u>

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FCC Federal Communications		<u>588</u>
Commission		
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	FCC > FCC E-filing > ELS > Gene	eric Search
OET Home Page		
	General Information	Experimental Licensing System Generic Search
-iling Options		
Form 405 - License Renewal	File Number:	
Form 442 - New	Call Sign:	
License	ERN:	
Form 702 - Assignment of	Applicant Name:	planet labs
License	Purpose of Operation	
Special Temperany Authority	(STA-type mings only):	
Add Attachmonts	Comments:	
Reply to Correspondence		
Amend/Complete Application	Disposal Date Range:	te
Return to 159 Form	Receipt Date Range:	te
File an Informal Objection	Expiration Date Range:	to
ne ar menne ogreener	Expiration Date Hange.	
Reports	Frequency Range.	to exact
Application Status	<u>Enr'.</u>	
Call Sign Search	Emission.	
Generic Search	Scope of Service:	
Point Radius Search	Experiment Type.	
	Transmitter City.	· · · · · · · · · · · · · · · · · · ·
Aiscellaneous	Application Status	•
Get ERN	Application Status	9
ELS Notification Website	Granted:	
Liser's Manual	Donding:	
Get Software	Dismissod:	
FAO	Dismissed:	
1114	Expired:	





## **Part 25 Commercial License**

- Get lawyers
- Initial meetings with FCC to provide context, timelines, and request feedback
- Pre-coordination with existing users in band
- File frequency application
  - For both satellites and ground stations
  - FCC process takes 9-12 months
- Public notice period for comments
  - Organizations may comment, usually negatively
  - SmallSat community should not be litigious: "Old aerospace" way is to submit last-minute Petition to Deny
  - FCC doesn't like to arbitrate, wants spectrum users to solve problems ourselves
  - Planet Spire Terra Bella coordination
- License grant
- Prove bond milestones have been achieved





## **Part 25 Approximate Costs**

- Lawyers fees
- FCC:
  - Application fee \$450k
  - Annual regulatory fee \$150k
  - \$5M Bond, released at milestones
    - Underwriter 1-2%: \$50-100k
  - Ground stations \$3k (per site)
- ITU Cost Recovery:
  - Advance publication \$570
  - Notification \$40k
- "Regulatory affairs" FTE
  - Adding additional ground stations
  - Annual reporting
  - Modifications to license





#### **Search FCC Database**

- <u>https://licensing.fcc.gov/myibfs/</u>
- All data is searchable, login not required





## Is a Part 25 license worth it?

- Costs: Lawyers + \$750k + FTE + 2 years
- When the rules were written, satellites cost \$100M+ and took 10 years to build
  - Existing users aren't pushing for change
  - FCC system designed years ago for/by Big Aerospace
- For university or single satellites, probably not worth it
  - Community: Do we want to change this?
  - FCC will listen to us, but we need to get together and propose rules
- ITU is looking at making licensing more streamlined
  - <u>Report ITU-R SA.2348</u>: Current practice and procedures for notifying space networks currently applicable to nanosatellites and picosatellites
  - <u>Report ITU-R SA.2312</u>: Characteristics, definitions and spectrum requirements of nanosatellites and picosatellites, as well as systems composed of such satellites
  - <u>Resolution 659</u> from WRC-15
  - WRC-19 Agenda Item 1.7 for small sat TT&C band





### **Other Countries**

- Any ground station in other countries must be licensed
- Each country has a different regulations, governing agencies, and associated fees
- Ground station providers can help with the paperwork
- Timeline is similar (or longer)





## **License Upkeep**

- Changing anything with your license triggers a new comment period:
  - New ground stations
  - New satellites
  - Change in frequencies/bandwidth
  - Coordinating with terrestrial users
- NOAA CRSRA licensing for remote sensing satellites
  - Annual reporting
  - Ground station inspections
  - Foreign agreements notifications
  - Change in corporate ownership
- "Regulatory Affairs" FTE





#### References

- ITU Symposium and Workshop on small satellite regulation and communication systems
  - Santiago de Chile, Chile, 7-9 November 2016
  - <u>http://www.itu.int/en/ITU-R/space/workshops/2016</u>
    <u>-small-sat/Pages/agenda.aspx</u>
- Spectrum Wiki
  - <u>http://spectrumwiki.com</u>





#### **Thanks!**

- Questions?
- <u>https://www.youtube.com/watch?v=5IE1Q9JvQUM</u>





#### **Backup Slides**



"Constellation Phasing with Differential Drag on Planet Labs Satellites." Cyrus Foster, James Mason, Vivek Vittaldev, Lawrence Leung, Vincent Beukelaers, Leon Stepan and Rob Zimmerman.



