Satellite Regulation: An introduction for new entrants

Ofcom / UK Space Agency
3 November 2017
1. Introduction

Philip Marnick, Group Director - Spectrum, Ofcom
Elizabeth Quintana, Head of satellite industry engagement, Ofcom
Aims

• Welcome new members of the UK Space Community
• Simplify a complicated regulatory process
• Introduce you to key members of the Ofcom and UKSA teams
• Help you to understand your responsibilities ......
• But also how we can help you

One-to-one meetings
• Early engagement to discuss your new projects
Structure of today

- Overview of satellite regulation
- Spectrum regulation overview

Coffee
- Spectrum – How to make a satellite filing
- Spectrum – How to license an earth station
- Outer Space Act licensing
- Summary

Lunch
2. Overview of satellite regulation

Justin Moore, Head of Space and Science, Ofcom
Richard Crowther, Chief Engineer, UK Space Agency
Why regulate?

Primarily because of potential for **physical damage** and **radio interference**

- Objects put into space have the potential to
  - To cause physical damage to other space objects, to people and objects on the Earth
  - To cause harmful radio interference to other space objects
- Conversely, objects put into space could suffer:
  - Physical damage from other space objects
  - Radio interference, potentially preventing communication with them

**Because of this, nations of the world have agreed international treaties on the use of space and radio spectrum**

- In addition, satellite earth stations on the Earth have the potential to interfere with, and be interfered by, other radio spectrum users
Why regulate?

Space is a **unique** resource

- UK is signatory to the main outer space treaties and conventions and a leading member of the United Nations
- UK has legal obligations to supervise activities of UK entities and is liable for actions of those entities in space
- UK recognises the unique nature of certain orbit regimes and is committed to protecting them through regulation
Basis of regulation and key bodies

- Use of outer space
  - Outer Space Treaty
  - Rescue Agreement
  - Liability Convention
  - Registration Convention
  - UK Outer Space Act

- Use of radio spectrum
  - ITU Radio Regulations
  - UK Wireless Telegraphy Act
UK Space Agency leads UK civil space policy

UK Space Agency is responsible for:

• leading the UK civil space policy and increasing the UK contribution to European initiatives
• building a strong national space capability, including scientific and industrial centres of excellence
• co-ordinating strategic investment across industry and academia
• working to inspire and train a growing, skilled UK workforce of space technologists and scientists
• working on national and international space projects in co-operation with industry and academia
• regulating the UK civil space activities and ensuring we meet international treaty obligations
Ofcom is the UK’s communications regulator

- Making communications work for everyone

- Regulate TV, radio and video-on-demand sectors, fixed-line telecoms, mobiles, postal services and spectrum use.

- Accountable to Parliament

- Regulatory principles

- Duty to ensure optimal use of radio spectrum

- Represent the UK internationally - including in the International Telecommunication Union (ITU)
Ofcom’s Space Spectrum Strategy

Enabling satellite broadband growth
- Better fixed broadband options
- Better broadband on aircraft and on ships

Enabling Earth Observation growth
- Many ways in which UK citizens benefit
- Wide range of new EO based applications

Existing benefits and new uses
- Growing and competing demands
- Careful consideration of co-existence conditions
**Satellite regulation overview**

**Satellite filing**
- Talk to Ofcom
- Preferably at least 2 months
- Submit filing (API / CRC)
- At least 9 months (best case), max 7 years
- Bring into Use
- Notify

**Earth station licensing**
- Talk to Ofcom
- ~4 weeks
- Earth station licence application
- Allow at least 6 weeks
- Earth station licence granted
- Earth station operational

**Outer Space Act licensing**
- Talk to UKSA
- Outer Space Act application
- OSA licence decision
- Launch
- Satellite operational
3. Spectrum regulation overview

Bharat Dudhia, Spectrum Policy Manager, Ofcom
Radio Regulations and small satellites

Radio regulations (RR) - rights and obligations

- Radiocommunication service definitions
- Frequency allocations and status
- Technical and regulatory conditions on the use of the bands
- Procedures (i.e. coordination and notifications, interference management, recoding of frequency assignments etc.)

- The RR are updated at every WRCs (World Radio Conference) and next WRC Oct/Nov 2019
- National regulations are largely based on the RR
- The RR is very important for space services due to nature of the applications
- Complying with national and international regulations essential in preventing harmful interference to other services
- Using the right bands (i.e. the use consistent with the RR allocations)
- ITU-R has been working on small satellite issues since 2012
Small satellites and impact on spectrum use / requirements

- Small satellites-> benefits & challenges
- Significant growth in launch of small satellites and the trend expected to continue
- Key applications -> Scientific / Educational / Commercial / Amateur / Government
- Typical characteristics – Low cost / Omni beam / Short duration (<3 years) / LEOs / short lead time
- Currently most operating in the amateur bands
- Lack of knowledge on orbital parameters in early stage of the missions -> biggest challenge
Small satellites requirements

Key requirements:

- Faster process
- Minimum national & international regulatory obligations and constraints
- Spectrum requirements -> 682-938 kHz for uplink and 625-2500 kHz for downlink (ITU report)
- Most prefer spectrum for TT&C below 1GHz but likely to move to higher frequencies in the future (ITU report)
ITU-R work on small satellite issues during 2012-15 study period

Review of regulatory procedures for notifying satellite networks to facilitate deployment of small satellite (Resolution 757)

Outcomes

- No specific measures, such as changes to satellite coordination and notification in the RR needed in respect of small satellites.
- Developed Resolution 68 on improving the dissemination of knowledge concerning the applicable regulatory procedures for small satellites

ITU-R also developed following reports

- **Report SA.2312** Characteristics, definitions and spectrum requirements of nanosatellites and picosatellites, as well as systems composed of such satellites
- **Report SA.2348** Current practice and procedures for notifying space networks currently applicable to nanosatellites and picosatellites
UK frequency allocation table (UK FAT) and satellite allocations

- UK frequency allocation table (UK FAT) details UK allocations and the uses.
- Link to online version of interactive UK frequency allocation table
  http://static.ofcom.org.uk/static/spectrum/fat.html#

Typical allocations for satellite applications

- 137-138MHz (downlink)
- 149- 49.9 MHz (uplink)
- 400.15-401 MHz (downlink)
- 401-402 MHz (downlink)
- 401-403 MHz (uplink) * The conditions on the use the band may change subject to outcome of WRC-19
- 449.75-450.25 MHz (uplink)
- 2025-2110 MHz (uplink)
- 2200-2290 MHz (downlink)
- 8025-8400 MHz (downlink)
WRC-19 and spectrum requirement for small satellites

WRC-19 agenda item 1.7

- UK supported new agenda item at WRC-15 to address spectrum requirement of small satellites
- Resolution 659 (WRC-15) sets out the guiding principles for work under this agenda item
- WRC-19 AI 1.7 focusing on two bands (a) 150.05-174MHz (b) 400-420MHz
- Finding a suitable spectrum within these bands is looking very challenging
- TT&C for uplink -> key requirement
Coordination of UK policy on WRC-19 agenda item on small satellite issue

- Coordination of UK policy on small satellite issue -> IFPG Working Group 2
- UK actively involved in CEPT/ITU-R to identify the suitable spectrum
- European policy -> CPG Project Team A -> CPG (European conference preparatory group)
- ITU-R Working Party 7B lead group on sharing studies and the CPM text (Conference preparatory text)
- WRC-19 agenda item 1.7 is a long-term solution
- Working with public bodies (i.e. MOD) for access to spectrum to address some immediate needs
Links to ITU-R Resolutions/Reports relating to small satellites

• **ITU-R Resolution 68** - Improving the dissemination of knowledge concerning the applicable regulatory procedures for small satellites, including nanosatellites and picosatellites  [http://www.itu.int/pub/R-RES-R.68-2015](http://www.itu.int/pub/R-RES-R.68-2015)

• **ITU-R Report SA.2312** - Characteristics, definitions and spectrum requirements of nanosatellites and picosatellites, as well as systems composed of such satellites  [http://www.itu.int/pub/R-REP-SA.2312](http://www.itu.int/pub/R-REP-SA.2312)

4. Spectrum: How to make a satellite filing

Callum Gray, Acting Manager - International Frequency Co-ordination, Ofcom
Satellite filings

Role of the International Telecommunication Union (ITU)

• Specialised Agency of the United Nations who coordinate telecommunication operations and services throughout the world
• 193 Member states
• ITU-R defines and manages the international framework for the use of spectrum and satellite orbits by radiocommunication services
Satellite filings

What is a satellite filing?

• Obtains international recognition for frequency assignments
• Contains technical characteristics that satellites can operate under
  • Frequency assignments
  • Emissions
  • Class of service
  • Orbital planes (NGSO)
  or
  • Orbital location (GSO)
Satellite filings

Role of Ofcom

- Notifying Administration of the United Kingdom
- Regulation of spectrum use
- Represent 25 UK satellite operators
- Manage 300+ satellite filings
Satellite filings

Number of active UK filings

Year

Number of filings

Satellite filings

Procedures for the Management of Satellite Filings

Ofcom aims to ensure that applications submitted to the ITU are consistent with the provisions of the ITU Constitution, Convention and Radio Regulations. These include compliance with the provisions of RR Article 5, 9 and 11.

• Due diligence requirements
  • Registered as UK Company
  • Project Plan
  • Potential Coordination Analysis

• For frequencies identified as UK 2.1, we liaise with MoD
Satellite filings

ITU Software

Data capture software for electronic notification of satellite networks and earth stations in the space radiocommunications services.

Software package which allows the capture and modification of graphical data relating to the electronic notification of satellite networks.

Software for validating electronic notices captured by the BR SpaceCap software; provides interactive validation facility in SpaceCap.

Software package for printing satellite networks / Earth stations from the SRS database.

Space Services E-learning

Submissions and supporting information should be emailed in .zip format to:
Ifc.enquiries@Ofcom.org.uk
Satellite filings

Timescales – Frequency Assignments not subject to coordination (Sub Section IA, RR)

Submit filing to Ofcom
Ofcom aim to submit to ITU within 10 working days

Submit API filing to ITU

ITU publish API/A special section
3 months for treatment by BR
4 months for comments from other Administration

ITU publish API/B special section

BR International Frequency Information Circular (BR IFIC)
Space Service

Submit notification and Bring into use assignments

Exclusion of territory
• Interference to the terrestrial services
• Interference to the space services
• Other

CHF 600 – (Edition) or CHF 3530 (Subscription)

Minimum 6 Months

MIN 9 MONTHS, MAX 7 YEARS!
Satellite filings

Timescales – Frequency Assignments subject to coordination (Sub-Section IIA, RR)

Submit filing to Ofcom

Ofcom aim to submit to ITU within 10 working days

Submit CR/C filing to ITU

ITU publish API/A special section

4 months for treatment by BR

ITU publish CR/C special section

4 months for comments from other Administration

BR International Frequency Information Circular (BR IFIC) Space Service

Special section

Submit notification and Bring into use assignments

MAX 7 YEARS!
**Satellite filings**

**Associated Costs**

- **ITU Cost Recovery**

  - API for NGSO (not subject to coordination) = 570 CHF
  - Notification for NGSO (not subject to coordination) = 7030 CHF

  15 days to withdraw submission before chargeable

- No fee *currently* charged by Ofcom
## Satellite filings

### Associated Costs

**ITU - Circular Letter CR/245**

Schedule of processing charges to be applied to satellite network filings received by the Radiocommunication Bureau on or after 1 January 2006

<table>
<thead>
<tr>
<th>Type</th>
<th>Category</th>
<th>Flat fee per filing (in CHF) (&lt; 100 units)</th>
<th>Start fee per filing (in CHF) (&lt; 100 units)</th>
<th>Fee per unit (in CHF) (&lt; 100 units)</th>
<th>Cost-recovery unit</th>
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<tr>
<td>1</td>
<td>Advance publication (A)</td>
<td>A1</td>
<td>Advance publication of a non-geostationary-satellite network not subject to coordination under Sub-Section IA of Article 9; Advance publication of inter-satellite links of a geostationary-satellite space station communicating with a non-geostationary space station provisionally not subject to coordination in accordance with the Rule of Procedure on No. 11.32, § 6 (MOD RRD04/35). Note: Advance publication also includes the application of No. 9.5 (AP/E special section) and will not be separately charged.</td>
<td>570</td>
<td>Not applicable</td>
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<tr>
<td>2</td>
<td>Coordination (C)</td>
<td>C1*</td>
<td>Coordination request for a satellite network in accordance with No. 9.6 along with one or more of Nos. 9.7, 9.7A, 9.7B, 9.11, 9.11A, 9.12, 9.12A, 9.13, 9.14 and 9.21 of Section II of Article 9, § 7.1 of Article 7 of Appendix 30A, Resolution 33 (Rev WRC-03) and Resolution 539 (Rev WRC-03). Note: Coordination also includes the application of Sub-Section IB of Article 9, Nos. 9.5D, 9.5A (CR/E special section) and 9.41-9.42 and will be separately charged.</td>
<td>20 560</td>
<td>5 560</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C2*</td>
<td></td>
<td>24 620</td>
<td>9 620</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C3*</td>
<td></td>
<td>33 467</td>
<td>18 467</td>
</tr>
<tr>
<td>3</td>
<td>Notification (N)</td>
<td>N1*</td>
<td>Notification for recording in the MIFR of frequency assignments to a satellite network subject to coordination under Section II of Article 9 (with the exception of non-geostationary satellite network subject to No. 9.21 only). Notation for recording also includes the application of Resolutions 4 and 49, Nos. 11.32A (see footnote a), 11.41, 11.47, 11.49, Sub-section IID of Article 9, Sections 1 and 2 of Article 13, Article 14 and will not be separately charged.</td>
<td>30 910</td>
<td>15 910</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N2*</td>
<td></td>
<td>57 920</td>
<td>42 920</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N3*</td>
<td></td>
<td>57 920</td>
<td>42 920</td>
</tr>
<tr>
<td>4</td>
<td>Plans (P)</td>
<td>P1</td>
<td>Part A Special Section for a proposed new or modified assignment in the Regions 1 and 3 List or feeder-link Lists of additional uses under §4.1.5 or proposed modification to the Region 2 Plans under §4.2.8 of Appendices 30 or 30A; or Part B Special Section for a proposed new or modified assignment in the Regions 1 and 3 List or feeder-link Lists of additional uses under § 4.1.15 (except Part B special section related to the application of Resolution 548 (RVRC-03)) or proposed modification to the Region 2 Plans under 4.2.19 of Appendices 30 or 30A.</td>
<td>7 030</td>
<td>Not applicable</td>
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<td></td>
<td></td>
<td>P2</td>
<td>Notification for recording in the MIFR of frequency assignments to space stations in the broadcasting-satellite service and its associated feeder-link in Regions 1 and 3 or Region 2 under Article 5 of Appendices 30 or 30A.</td>
<td>11 550</td>
<td></td>
</tr>
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<td></td>
<td>P3</td>
<td>Coordination request in accordance with Article 2A of Appendices 30 and 30A.</td>
<td>12 000</td>
<td>Not applicable</td>
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<td></td>
<td></td>
<td>P4</td>
<td>Publication associated with the conversion of an allotment into an assignment in accordance with the procedure of Subsection IA of Article 6 of Appendix 30B, or the recording of the list of existing systems in Part II of the Plan in accordance with the procedure of Subsection IB of Article 6 of Appendix 30B, or the introduction of subregional systems in accordance with the procedure of Subsection II of Article 6 of Appendix 30B, or the supplementary provisions applicable to additional uses in accordance with the procedure of Subsection III of Article 6 of Appendix 30B.</td>
<td>40 560</td>
<td></td>
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</table>

Units= The number of frequency assignments \( \times \) Number of classes of station \( \times \) Number of emissions, summed up for all frequency assignment groups

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**Units**

- \( \times \) The number of frequency assignments
- \( \times \) Number of classes of station
- \( \times \) Number of emissions
## Satellite filings

### Radio Regulation References

<table>
<thead>
<tr>
<th>Elements</th>
<th>Provisions</th>
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<td>Procedures</td>
<td>Article 9 &amp; 11</td>
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<td>Submission format</td>
<td>Appendix 4</td>
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<tr>
<td>Technical and operational limits</td>
<td>Article 5, Articles 21 &amp; 22 etc.</td>
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<td>Criteria and methods to identify coordination requirements</td>
<td>Appendix 5 (Appendices 7 &amp; 8)</td>
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</tbody>
</table>
5. Spectrum: How to license a satellite earth station

James Richardson, Spectrum Policy Advisor, Ofcom
How to license a satellite earth station

Licensing principles

• Wireless Telegraphy Act 2006, Communications Act 2003
• Duty to ensure optimal and efficient use of radio spectrum
• To use spectrum in the UK you need a licence or be exempt from licensing
• UK licensing only, no space segment licensing
• Receivers are exempt from licensing, but ‘Recognised Spectrum Access’ (RSA) is available in selected bands, on a voluntary basis
How to license a satellite earth station

Types of licence

• Aeronautical and maritime radio
• Business radio
• Microwave links
• Programme making and special events (PMSE)
• Satellite earth stations
• ...and many more
How to license a satellite earth station

Satellite earth stations

- Type of authorisation depends on earth station and frequency band

- For cubesat TT&C – “Non-Fixed Satellite Earth Station” licence
How to license a satellite earth station

Process for licensing

- Licence applications forms [here]
- Technical characteristics in a separate spreadsheet (location, frequency, power, antenna gain and pointing etc)

• Approximate timeline:

  - Talk to Ofcom: 4 weeks
  - Submit licence application: 6 weeks (10 weeks if external coordination)
  - Pay licence fee: 3 days
  - Licence granted: Earth station operational
How to license a satellite earth station

Licence fees

- Fee depends on type of licence and frequency band, details [here](#).
- Some fees are fixed (administration fee).
- Some fees are based on Administered Incentive Pricing (AIP).
- “Non-Fixed Satellite Earth Station” licence fee is fixed at £500 per year (renewable annually).
- Licence fees are subject to review periodically.
6. Outer Space Act licensing

Richard Crowther, Chief Engineer, UK Space Agency
Cubesats within the Outer Space Act

Prof. Richard Crowther
Chief Engineer, UK Space Agency
Outer Space Act

OUTER SPACE TREATY
Outer Space Act

UK OUTER SPACE ACT

- RESCUE AGREEMENT
- LIABILITY CONVENTION
- REGISTRATION CONVENTION

OUTER SPACE TREATY
PHASE 0
Mission Analysis

PHASE A
Feasibility

PHASE B
Preliminary Definition

PHASE C
Detailed Definition

PHASE D
Qualification & Production

PHASE E
Launch & Operations

PHASE F
Disposal

OUTER SPACE ACT LICENSING PROCESS

Preliminary Design Review (PDR)

Critical Design Review (CDR)

Flight Readiness Review (FRR)

Pre-Application Consultation

Application Submission

Analysis of Data Provided

Licencing Decision

Compliance Monitoring
<table>
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<tr>
<th>WHO?</th>
<th>WHY?</th>
<th>WHEN?</th>
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<td>HOW?</td>
<td>WHAT?</td>
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</table>
PRIMARY ELEMENTS OF OPERATIONAL RISK

HOW?
WHAT?
WHERE?
PRIMARY ELEMENTS OF OPERATIONAL RISK

LAUNCHER

PLATFORM/PAYLOAD

OPERATING/DISPOSAL ORBIT
1: PRIMARY LAUNCH ASSESSMENT (BASELINE)
2: SECONDARY LAUNCH ASSESSMENT (DELTA)
3: TERTIARY LAUNCH ASSESSMENT (EXACT REPEAT)
P: PAYLOAD ASSESSMENT (IN-ORBIT)
<table>
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<th>INFORMATION REQUIREMENTS OVERVIEW</th>
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<td>Launch system description (including functionality, performance and operating characteristics)</td>
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<td>Organisational Roles, Responsibilities and Authorities</td>
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<td>Safety Processes and Procedures for Launch Operation</td>
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<tr>
<td>(including historical and predicted reliability)</td>
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<td>Accident Investigation Outcomes</td>
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<td>General Mission Description</td>
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<td>Trajectory Information and Impact Points (to include launch trajectory and azimuth; ground track</td>
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<td>and land mass over-flight; sequence of major events; nominal impact locations; parking,</td>
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<td>operational and disposal orbits; operations; flight termination criteria)</td>
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<td>Risk Assessment to include Failure Analysis, Consequence Estimation, Risk Management approach</td>
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<tr>
<td>and Safety Implementation</td>
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</table>
PRIMARY ELEMENTS OF OPERATIONAL RISK

LAUNCHER

PLATFORM/PAYLOAD

OPERATING/DISPOSAL ORBIT
PRIMARY ELEMENTS OF OPERATIONAL RISK

LAUNCHER

PLATFORM/PAYLOAD

OPERATING/DISPOSAL ORBIT
Spatial Density

orbit of object
Collision Probability

Increasing orbital inclination
Orbital Lifetime

Orbital Lifetime (yrs)

25 years threshold

perigee altitude (km)

Orbital Lifetime (yrs)

25 years threshold

perigee altitude (km)

eccentric orbit (e = 0.05)

increasing eccentricity

circular orbit (e = 0)
LEO satellite injected into orbit less than 25 years

LEO satellite injected into orbit >25 years with deorbit system

LEO satellite injected into orbit >> 25 yrs, no deorbit system
MANAGING GENERAL RISK

THIRD PARTY LIABILITY

INSURANCE COVER

INFORMED TECHNICAL ASSESSMENT

SYSTEM INFORMATION REQUIREMENTS

OVERSIGHT AND COMPLIANCE MONITORING

RISKS MOVE FROM OPERATOR TO REGULATOR
MANAGING CUBESAT RISK

THIRD PARTY LIABILITY

LIMITED EXPOSURE TO LIABILITY

REDUCED INSURANCE COVER

REDUCED TECHNICAL ASSESSMENT

PRE-DETERMINED ANALYSES

REDUCED SYSTEM INFORMATION

USE OF STANDARD MODELS

REDUCED COMPLIANCE MONITORING

STATUS/HEALTH REPORTING

RISKS AND BURDEN BALANCED

COSTS TO OPERATOR AND REGULATOR REDUCED
Platform conforms to Cubesat standard

Cubesat ejection from dispenser on ISS

Cubesat injected into orbit < 25 years
7. Summary
What have we covered...

• What is regulated and why
• Who to talk to and when
• How to identify suitable frequencies
• How to make a filing for your satellite
• How to get a spectrum licence for your earth station
• How to get a OSA licence your satellite
Satellite regulation overview

**Satellite filing**
- Talk to Ofcom
- Submit filing (API / CRC)
- Preferably at least 2 months
- At least 9 months (best case), max 7 years
- Bring into Use
- Notification

**Earth station licensing**
- Talk to Ofcom
- Earth station licence application
- Allow at least 6 weeks
- Earth station licence granted
- Earth station operational

**Outer Space Act licensing**
- Talk to UKSA
- Outer Space Act application
- OSA licence decision
- Launch
- Satellite operational
If you want to find out more or get more involved

- Sign-up for Radio Spectrum email updates from the Ofcom website www.ofcom.org.uk
- Sign-up for Ofcom’s Satellite Consultative Committee (contact debby.oliver@ofcom.org.uk) – meets approx. twice a year and provides overview of current satellite spectrum regulation issues (next 17 November)
- Sign-up for Ofcom’s international preparatory groups
  - International Frequency Planning Group Working Group 2 (science and some small sat issues) bharat.dudhia@Ofcom.org.uk
  - International Frequency Planning Group Working Group 3 (satellite issues) nandan.patel@ofcom.org.uk
- For queries about satellite filings please contact ifc.enquiries@ofcom.org.uk
- For anything else elizabeth.quintana@ofcom.org.uk
Thank you for listening