Preventing Harmful Interference to Satellite Systems

The Technologies

Mark RAWLINS – 10th June 2013

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Eutelsat mission objectives

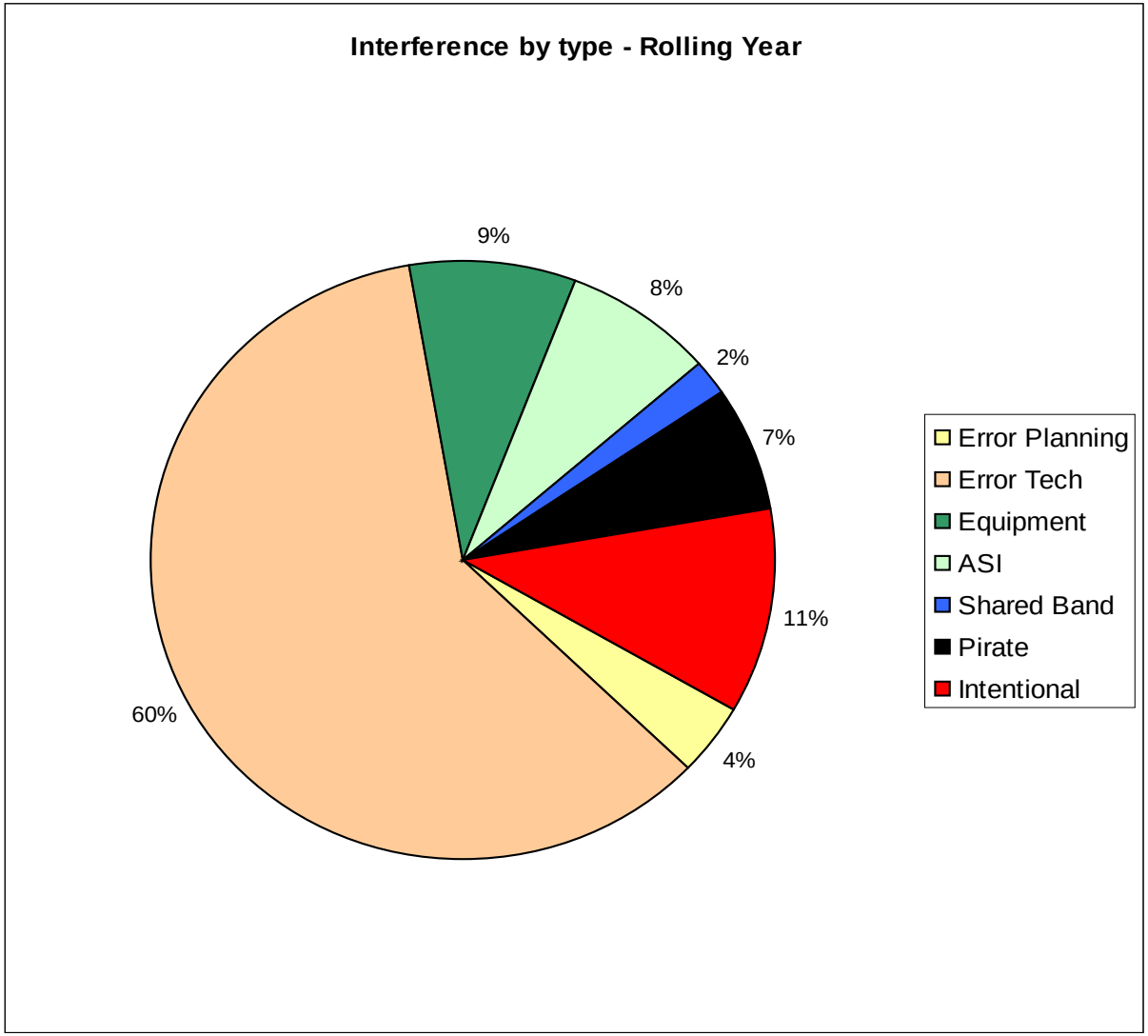
- **Our mission** is to provide our clients the **satellite infrastructure adapted to their needs**
  - ➢ It means High **Performance**, High **Availability**, High **Reliability** and **Sustainability**
- These needs evolve with time according to market evolution, technology, competition, regulation and geo-political environment
- Satellite operators maintain **a high investment ratio** to develop satellites and ground networks that can best provide space systems to meet these requirements
- In this context, RF interference is the single largest factor affecting service quality of satellite services, **deliberate jamming**, i.e. a signal transmitted by a third party to obstruct transmissions is a relatively **new factor** with **consequences in all areas** of the running of the business of a satellite operator

Eutelsat Satellite Service Operations

- Ensure the service continuity, availability and quality of the satellite capacity commercialised by Eutelsat
- Assure support to customers and users for accessing the satellite capacity and resolving any related problems
- Assure the availability of a monitoring network and monitoring systems that allows the best possible availability of the tools necessary to analyse problems affecting any customer service on any part of the satellite fleet

Interference to Satellite Services

- **Accidental Sources**
  - Human Error
  - Adjacent Satellite
  - Equipment failure
- **Deliberate Sources**
  - Jamming
  - Pirating



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Common Causes of Interference

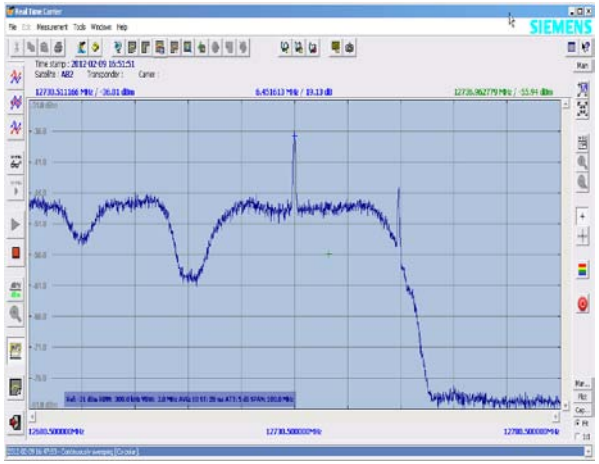
- **Human Error**
  - Wrong time slot
  - Wrong Satellite
  - Wrong frequency
  - Wrong or bad polarisation setting
  - Incorrectly pointed antenna
- **Faulty equipment or cabling**
- **Poor Quality ground systems**
  - Poor antenna specifications – overspill into other adjacent satellites
  - Lots more equipment out there – raising the probability of problems
  - Pressure to lower manufacturing costs – maybe less reliable
  - New technologies and functions – eg Autodeploy systems

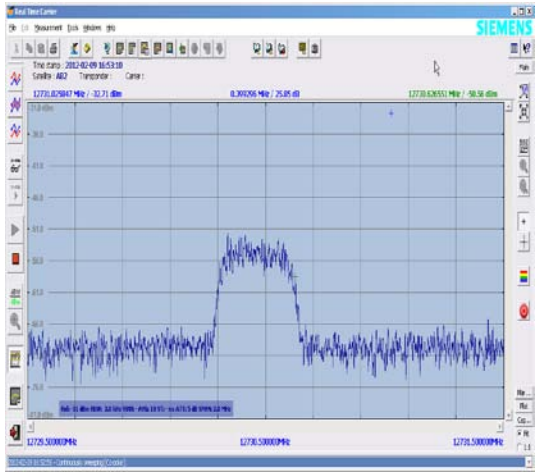
“Now where’s that 500Watt HPA I had?”

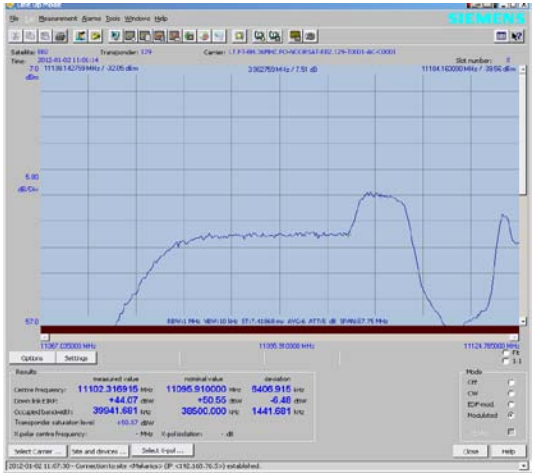
More satellites, less orbital spacing require respecting tighter technical specifications

Reducing Interference

- Antenna type approvals and ESVA testing
- Carrier ID – Adopted as DVB standard Feb 2013, ETSI in May 2013.
- Training Programs
- Communication
- Statistical analysis - identification of problem areas
- SDA – A means of rapidly sharing information with other satellite operators







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When Interference is deliberate

Pirating

- **Unauthorised use of satellite capacity**
  - Causes disruption to legitimate services

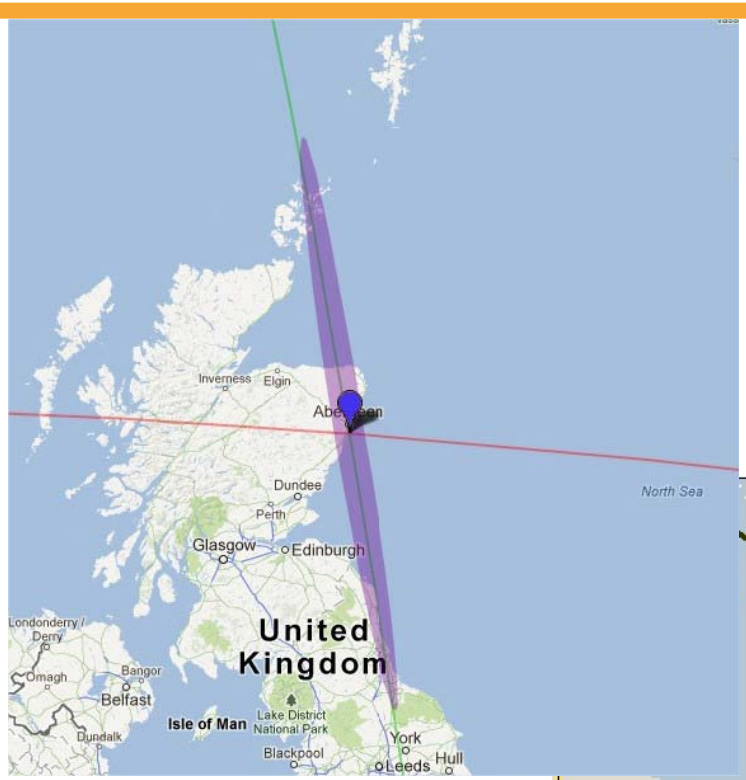
Jamming

- **Interfering signal characteristics**
  - Clean Carrier or Empty modulated carrier
  - Frequency of interfering carrier
- **Content or Origin of target carrier**
  - Contains politically sensitive channel(s)
  - Audio Language or target audience of channels
- **Aggravating Circumstances**
  - Political situations
  - Social unrest and demonstrations
- **Changing parameters**
  - Are changes to the target carrier tracked by the interfering carrier?
  - Do changes to the content of the target carrier result in removal of the jamming carrier?

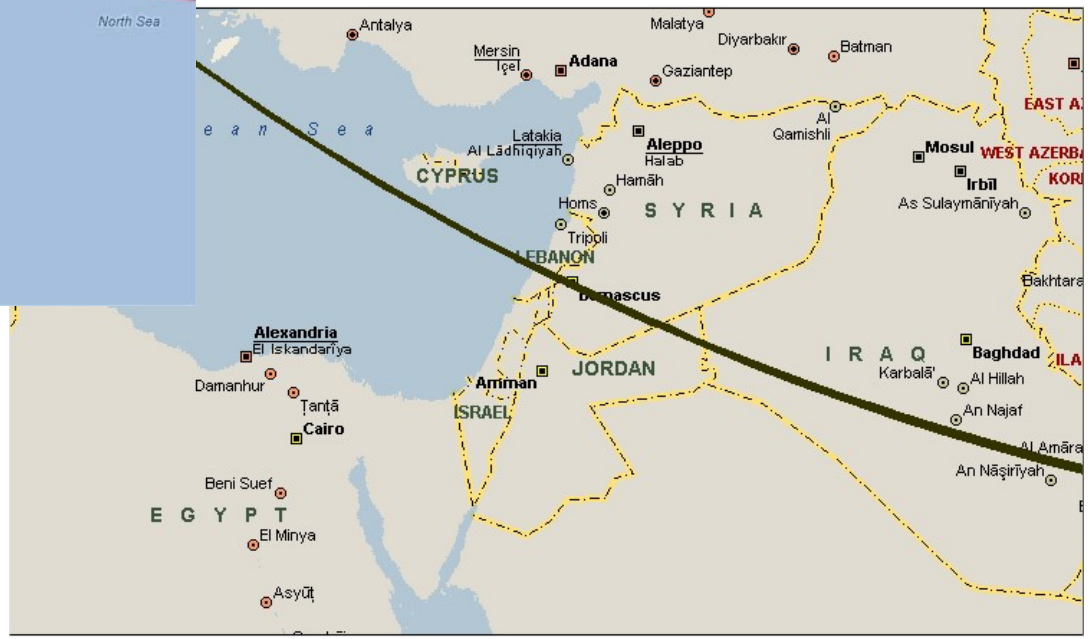
When Jamming Occurs

- Try to restore the legitimate service by increasing uplink power
- Change of uplink coverage, if available
- Provision of alternative capacity if appropriate or possible
- Dialogue with affected customer to identify potential target services
- Identify the source of the jamming signal – geolocalise

Comparison of two types of situation



Fast and accurate, the signal is modulated



More samples required to produce result – a series of measurements are required – a sinusoidal (CW) interference

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Improving Precision

- Making multiple measurements
- Making measurements to correct satellite position and velocity errors
- Modifying periodical manoeuvres to increase the rate of change between satellites

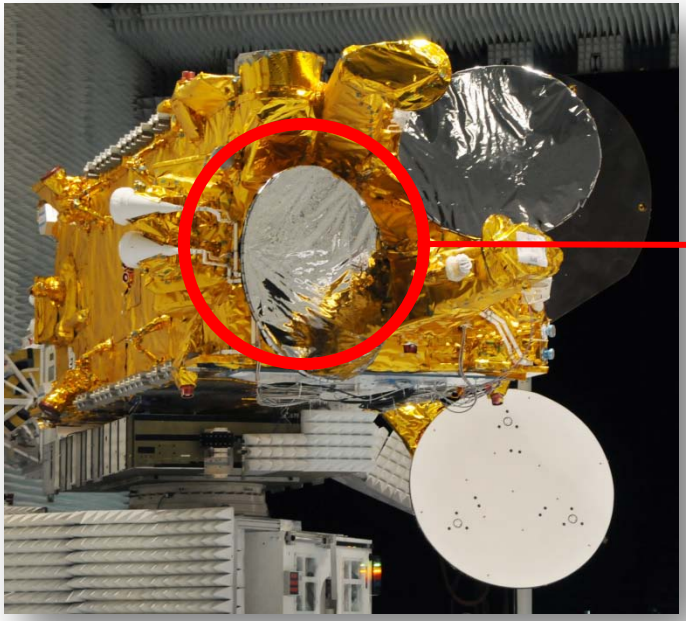
Jamming and new challenges

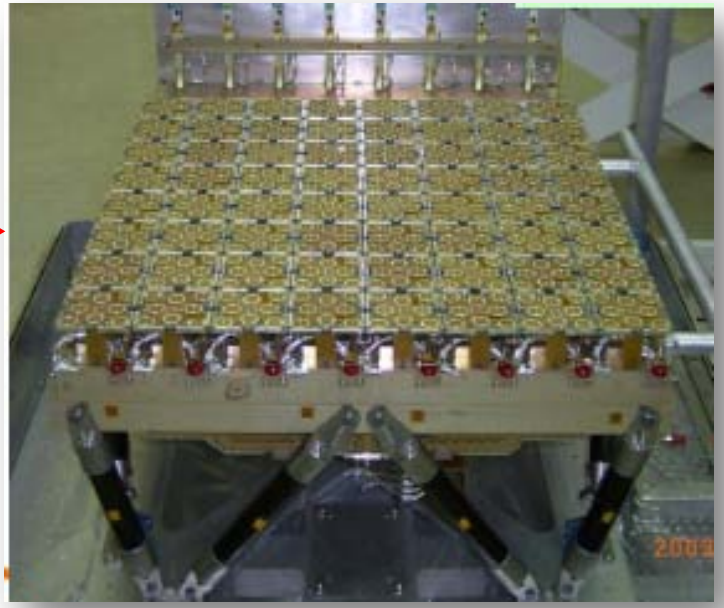
- The nature of intentional jamming forces to re-think practically across the board for a satellite operator for **monitoring the QoS delivered to our clients**, **detection of jamming** and **implementing counter-measures:**
  - Satellite concepts and technology
  - Ground monitoring systems
  - Consumer terminals
  - Organization of teams and processes, internally within the company and with our clients
- Actions need to be also undertaken through **associations** of peers to counteract jamming actions, and through **institutional and political actions** to raise awareness for **new regulatory and legal framework**
- The challenge is to develop the most advanced techniques in space and on the ground that can **bring more resilience against jamming** and to develop highly skilled integrated teams that can react quickly and efficiently
- **It is the people, more than the technology, that ultimately raise the level of QoS**

Future Technical Trends - Geolocation

- **Faster**
  - Pre-setting of ground-based geolocation of equipment
  - Exchange of data between satellite operators
- **Independent**
  - Geolocation is done today by triangulation between adjacent satellites (the victim satellite and one adjacent satellite)
  - Tomorrow will be done independently on board the satellite
- **More accurate**
  - Geolocation accuracy by triangulation depends on angular separation between satellites and satellite ephemeris accuracy
  - Improvement with on board jamming directional detection

Future Technical Trends – Satellite Receive antennas





Mechanical reflector antennas

- beam shape is fixed
- jamming direction detection achieved separately
- isolation from jamming is provided
  beam pointing mechanically away
  from the jamming direction(s)

TODAY

Active antenna (Earth deck)

- beam shaping electronically
- shaping of useful receiving zones
- also used for jamming direction detection
- shaping of receiving beam for exclusion zones

TOMORROW

Future Technical Trends - Conclusion

- **Other counter-measures can also be devised, such as agility in uplink frequency for a given downlink broadcast frequency:**
  - Implemented with new generation agile down-converters **on our next E8WB satellite** procured from Thales Alenia Space, with support from ESA and CNES
  - Can be applied to TCR sub-systems for increased resilience and operational flexibility.
    Will be implemented on E8WB
  - Technique can be generalized further with a pool of frequencies to create evasive feeder links for broadcast content
- **Home receive equipment, but more difficult to implement**
  - Design of new, more resilient access schemes and radiofrequency waveforms
  - Need for a standard to be accepted, approved and wide scale equipment roll-out
- **Techniques can be devised and teams can be trained, but a global action plan and coordination between all concerned are key to limit and possibly stop what is a pollution of the natural resource of spectrum**

SDA – Space Data Association

- **SDA Executive Members:**

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- **Technology Adviser / SDC Operator:** agi

- **Space Data Center:**
  - Verified, normalized data
  - Fully automated operations backed by experts 24/7

- **Open to all satellite operators in all orbits**

- **Strong legal agreement protect all participants from disclosure / misuse**

SDA – Space Data Association – The Mission

- **Increase safety of flight**
  - Automatic conjunction assessment
  - Includes planned maneuvers
- **Deal with the growing problem of RFI**
  - RFI Alerts to focused distribution
  - RFI historical event search
  - Generation of geolocation data sets
  - Carrier ID database
- **Enable more efficient operations for all**
  - Reliable contacts database for satellite operators – technical and operations personnel