AWS-2 and AWS-3 Interference

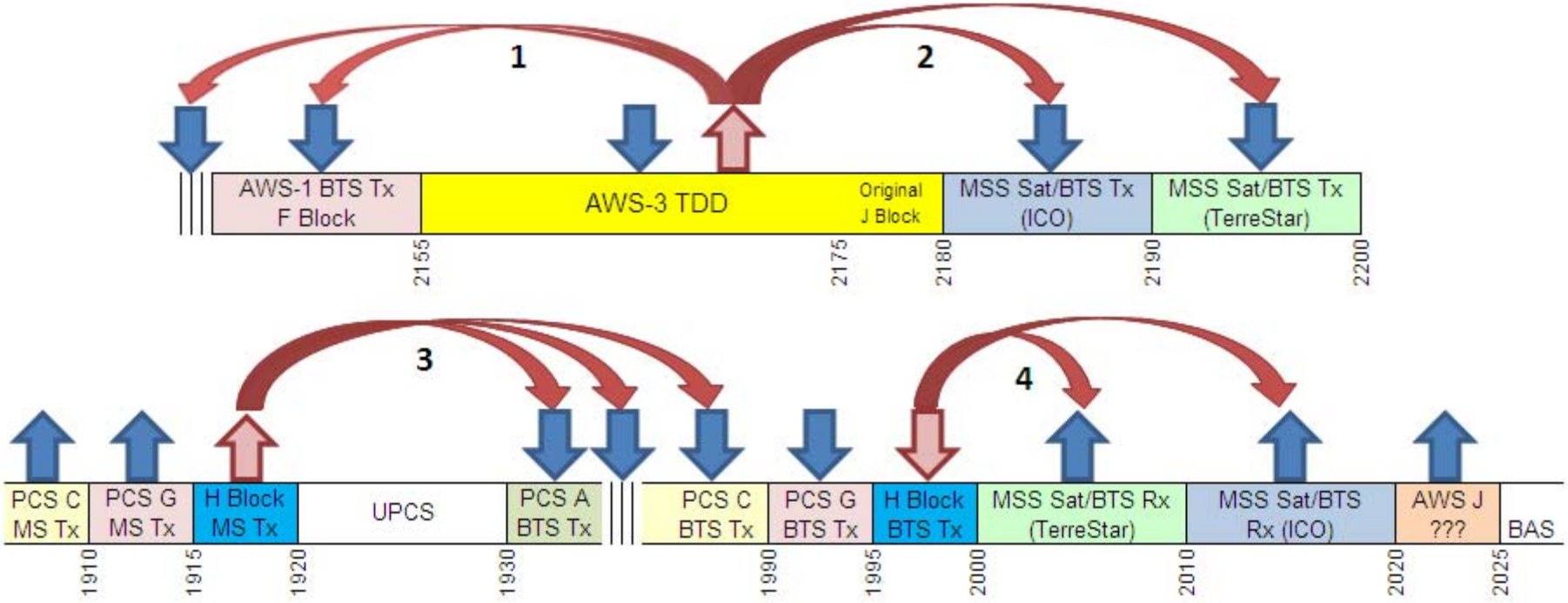
ICO and the freedom figure logo are trademarks of ICO Global Communications. All other trademarks are the property of their respective owners.

Summary

- FNPRM Band Plan
- AWS-2 H Block Interference
  - To MSS Satellite Receivers
  - To ATC Base Stations
- AWS-3 TDD Interference
  - Mobile to Mobile Interference to Satellite Devices
  - MSS/ATC Device Receiver Overload
  - OOBE Interference to MSS/ATC Devices

FNPRM Band Plan

- Four interference boundaries:



- Boundaries 2 and 4 impact ICO's MSS/ATC system

Boundary 4: H Block Interference to MSS Satellite Receivers

- H Block base station transmit would be directly adjacent to MSS/ATC receive
- H Block in-band power will cause severe receiver noise rise at the satellite
  - ICO G1 has been successfully launched – no modifications are possible
  - ICO's satellite must cover the entire 20 MHz MSS allocation
  - Receiver filters will not be able to reject energy from base station transmissions in the upper 1.5 MHz of the H Block
  - This H Block interference will raise noise levels on the satellite feeder link
  - To avoid saturation, the feeder power amplifier will reduce gain, reducing satellite return link performance by several dB (impact worsens as more H Block base stations are deployed) thus greatly impacting mobile satellite communications
- ***To protect MSS operations, the H Block base stations must not transmit in 1999-2000 MHz - this must be established as guard band***
- ***To control interference received by the satellite, aggregate base station EIRP for 1995-1999 MHz must not exceed 32 dBW per sector***

Boundary 4: H Block Interference to ATC Base Stations

- The FNPRM proposal of 43 + 10 log P for the H Block would rely on commercial negotiations to resolve the H Block and MSS/ATC base-base and mobile-mobile interference boundary at 2000 MHz
- This approach is highly inequitable to MSS/ATC – coordination works when services are similar, such as neighboring terrestrial systems, but does not work when one system is disadvantaged, such as a satellite system
  - Satellite communication requires an optimal link budget
  - All MSS/ATC devices must work on the satellite
  - Device transmit filter performance is already maximized to meet the existing 43 + 10 log P requirement at 2000 MHz and still close the loop with the satellite
  - More stringent device filtering will severely harm satellite communications
- ICO requests protection similar to the EBS/BRS rules to protect from base-to-base interference:
  - BTS-BTS separation distances greater than 1.5 km: OOBE of 70 + 10 log P at 3 MHz from the channel edge
  - BTS-BTS separation less than 1.5 km: OOBE of 70 + 10 log P – 20 log (D_{km}/1.5) at 3 MHz from the channel edge
  - When co-located, limit the undesired signal level at the ATC base station receiver to no more than -108 dBm/5 MHz (scaled to the appropriate bandwidth)

H Block Summary

- A combination of guard band, power limits, and out-of-band emissions limits must be implemented to avoid interference to satellite and ATC base station receivers.

- Satellite Protection:
  - 1 MHz guard band from 1999-2000 MHz
  - Aggregate BTS EIRP per sector limit of 32 dBW for 1995-1999 MHz

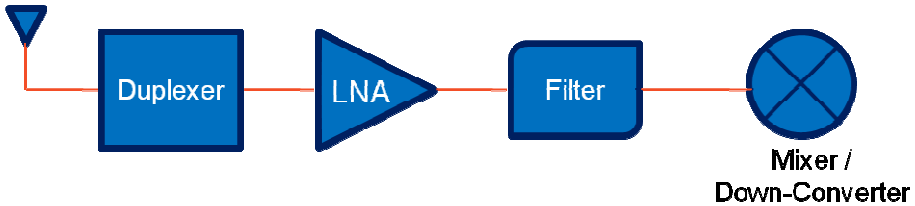
- ATC Base Station Protection:
  - OOBE Limits:
    - BTS-BTS separation distances >1.5 km: OOBE of 70 + 10 log P at 3 MHz from the channel edge
    - BTS-BTS separation <1.5 km: OOBE of 70 + 10 log P – 20 log (D_{km}/1.5) at 3 MHz from the channel edge
    - When co-located, limit the undesired signal level at the ATC base station receiver to no more than -108 dBm/5 MHz (scaled to the appropriate bandwidth)

AWS-3 TDD Interference

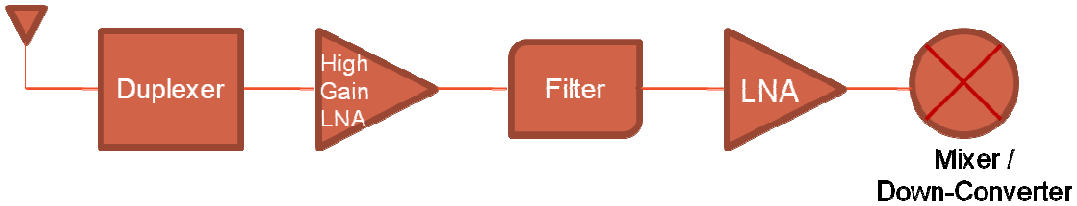
Boundary 2: Mobile to Mobile Interference to Satellite Devices

- As shown below, the receive chain in the RF front end of a satellite device is inherently more sensitive than the RF front end of a traditional PCS or cellular mobile

Typical RF front end of PCS/cellular mobile (receive):



Typical RF front end of Satellite mobile (receive):



- The LNA in the satellite front end has higher gain than a typical PCS LNA, and is cascaded with a second LNA to minimize noise figure and close the link to the satellite; however, this design also reduces receiver blocking performance, making satellite devices more susceptible to adjacent channel interference
- Filter design imposes similar constraints given the imperative of low insertion loss for satellite coverage
- Thus mobile-to-mobile interference will be more severe when satellite mobiles are the victim than when PCS-like mobiles are the victim

Boundary 2: AWS-3 TDD Will Cause Receiver Overload

- ICO mobiles require guard band to avoid receiver overload from TDD handsets
  - ICO stated its support for TDD when J Block provided frequency separation, and assuming proper service rules for AWS-3 and ICO equipment design modifications
  - Extending TDD operations to 2180 MHz will cause receiver overload to MSS/ATC mobiles, especially given the sensitive device front end receiver
  - ICO current device design does not account for TDD operation in AWS-3, but preliminary evaluation indicates a receiver blocking level of -56 dBm is possible (in 2170-2180 MHz region)
  - Combined with the isolation provided by 3 meters of minimum separation, **MSS/ATC devices require 10 MHz guard band from AWS-3 TDD transmission**

AWS-3 Device Tx Level:	23	dBm	From FNPRM
Receiver Blocking Level:	-56	dBm	ICO prelim spec for 2170-2180 MHz
Isolation Required:	79.0		Rcvr Blocking Level - Device Tx Level
Isolation from 3 m separation:	49.0	dB	
Additional losses:	3	dB	
Filtering Attenuation Required:	27.0	dB	
Minimum Guard Band:	**10**	**MHz**	Source: FBAR filter rolloff

Boundary 2: AWS-3 TDD OOBE Will Cause Receiver Noise Rise

- AWS-3 TDD out-of-band emissions must also be controlled
  - The AWS-3 TDD device must contain sufficient filtering to control emissions into the MSS/ATC device receive band, given the sensitive device receiver
  - One service supported by MSS/ATC is GMR two-way communications via the satellite
  - OOBE calculation for GMR is shown below:

Thermal noise:	-174	dBm/Hz
Noise Bandwidth:	156.25	kHz
Total noise:	-122	dBm/156.25 kHz
Receiver noise figure:	1.9	dB
Receiver noise floor:	-120.2	dBm
Isolation from 3 m separation:	49.0	dB
Additional losses:	3	dB
OOBE Limit at 2180 MHz:	-60.1	dBm/MHz

OOBE Calculation for ICO GMR Service

  - For a 3 meter separation between devices, the maximum signal level permissible at the antenna of the AWS-3 device is -60 dBm/MHz at 2180 MHz
- **This translates to a required OOBE limit of 90 + 10 log P with a 1 MHz measurement bandwidth**
- The FNPRM proposal of 60 + 10 log P is insufficient, corresponding to an interference radius of 100 meters, greatly impacting MSS/ATC device performance

AWS-3 Summary

- Designating the 2155-2175 MHz AWS-3 block as flexible use must be accompanied by regulatory requirements to protect adjacent MSS user terminals:
  - Mandatory guard band from 2170-2180 MHz
  - Device EIRP limit of 200 mW below 2170 MHz
  - Device OOBE must not exceed 90 + 10 Log P at 2180 MHz, with 1 MHz measurement bandwidth

- AWS-3 expansion to 2180 MHz must not occur given the significant uncontrolled interference to MSS/ATC devices that would result.