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Universal Type Approvals for Ka-Band Ground Equipment

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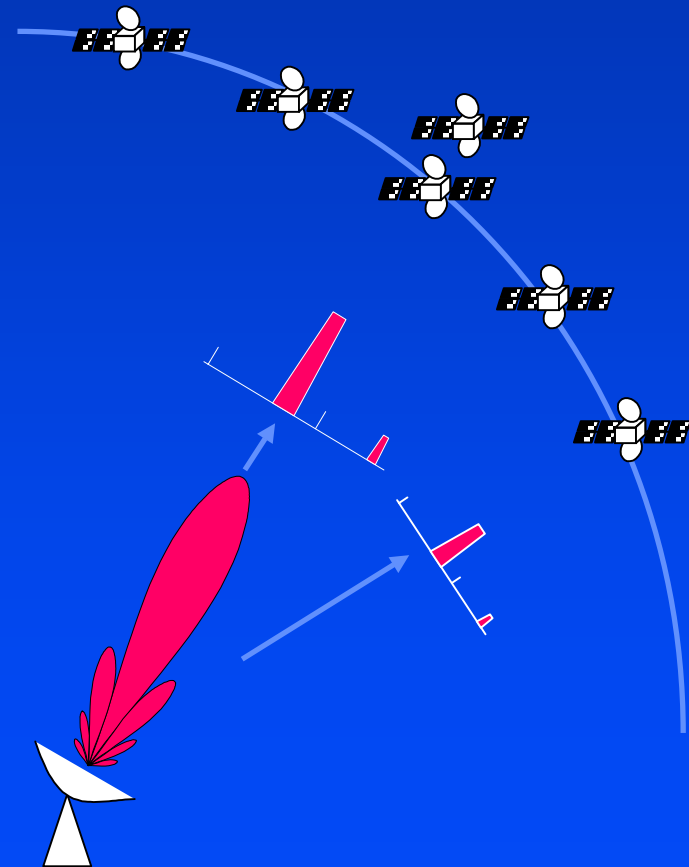
- What is the Global VSAT Forum
- Spectrum and arc sharing
- Performance standards and bodies
- On-site verification vs. type approval
- GVF approach to mutually-recognized approval data
- Issues with on-site verification at Ka-band
- Issues with lab & range measurements for type approval at Ka-band
- Upcoming work and opportunities to participate

What is the Global VSAT Forum?

- International pan-satellite industry association
- Over 100 member organizations
- Most major satellite operators, equipment manufacturers, and network integrators
- Advocates global de-regulation and fair licensing of satellite communications services
 - Regulatory Working Group
- Forum for coordination of test procedures and performance standards between manufacturers and satellite operators
 - Mutual Recognition Arrangement (MRA) Working Group
 - Focus on arc and spectrum sharing, not interoperability

Spectrum and Arc Sharing

- Unrelated systems share the GEO arc space at common frequencies
- Also may share common slot and different frequencies
- In-band vs. out-of-band spurious power spectral density
- Stability of transponder BW and power resource consumption
- On-axis vs off-axis limits



Coordination

- Satellite operators and government agencies impose limits on off-axis and out-of-band emissions from earth stations
- Constraints can be
 - Direct (e.g. off-axis EIRP spectral density maxima)
 - Indirect (antenna gain patterns and transmitter spectrum)
- Specifications generally flow down from the International Radio Regulations (UN/ITU), but can be augmented by:
 - Standards bodies (e.g. ETSI)
 - Regulatory agencies (e.g. FCC)
 - Satellite operators (e.g. Intelsat, Eutelsat)

Performance Standards

- **Interoperability**
 - Modulation, protocol (e.g. DVB-RCS)
- **Interference prevention**
(GVF-MRA focus)
 - Inter-satellite:
Off-axis emissions
Out-of-band emissions
 - Intra-satellite:
EIRP stability, G/T, spectral mask
 - Inter-service:
GEO - MEO - LEO
Fixed wireless - Satellite
Radionavigation - Satellite



- Radio Regulations
- Recommendations



- Directives
- e.g. R&TTE



Regulators



Standards bodies



- Satellite operators
- Transponder mgt
 - Coordination agreements

Equipment verification

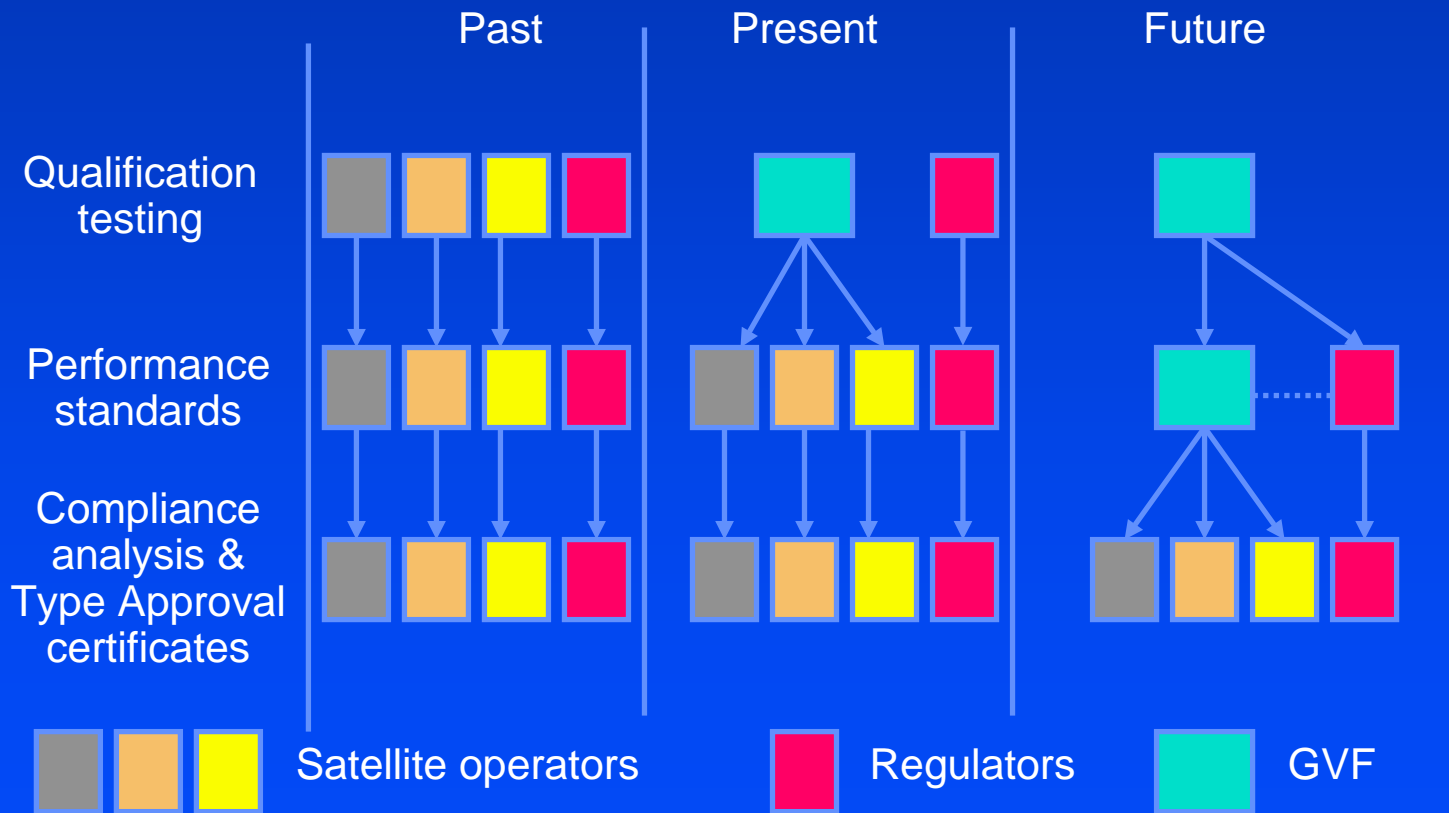
- By *default*, regulators and operators require on-site testing of every individual earth station
- Typical tests:
 - Antenna patterns
 - Antenna gains
 - Cross-pol discrimination or VAR
 - Frequency and EIRP stability
 - Spurious signals
 - G/T
- Requires motorized mount for antenna pattern tests
- Requires cooperating earth station resources
- Very expensive - costs can easily make terminal not feasible.
- Particularly problematic at Ka-band

But in practice...

- In most cases, the regulator or operator will allow many stations to be installed based on some kind of qualification testing (“type approval”)
- Type approvals (general sense) range from
 - Implicit (e.g. submit data as part of blanket licensing), to
 - Explicit (e.g. Intelsat format type approval program)
- Data is taken on calibrated antenna ranges and on the bench for electronics.



How does the industry manage type approvals?

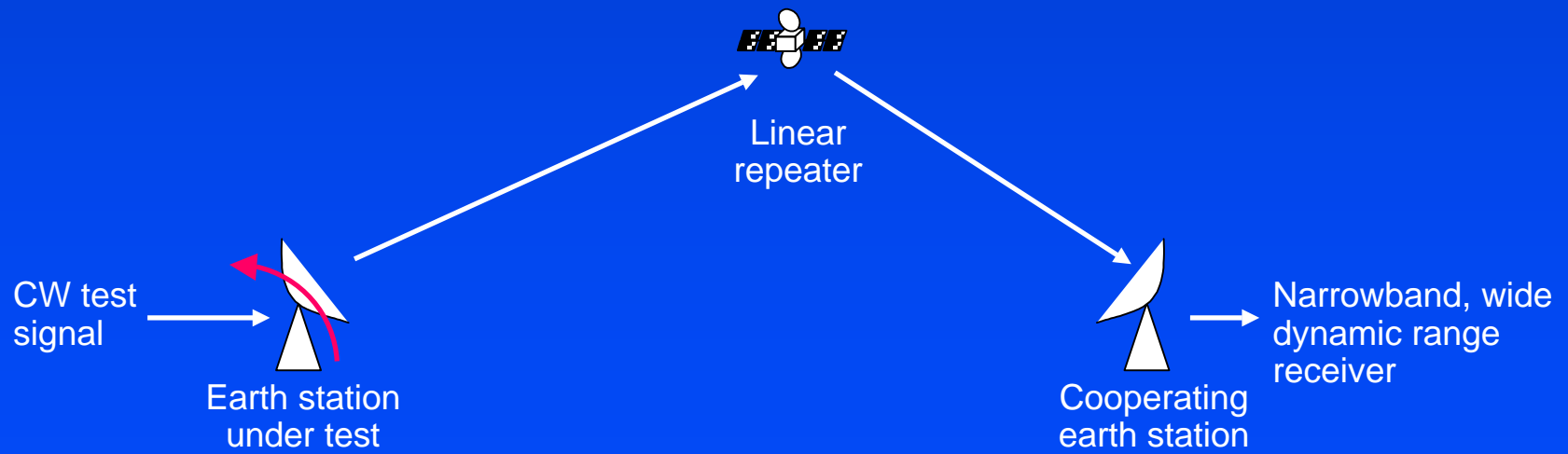


GVF-101 MRA process (abridged)

- Member satellite operators unanimously elect Authorized Test Entities (ATE's).
 - Seven ATE organizations elected as of Sept 2001.
- Manufacturer designates equipment and a Primary Operator
- Primary Operator concurs & designates an ATE
- Manufacturer runs suite of tests on production sample units with ATE as witness
- Manufacturer submits Data Package, including extensive design review and quality audit, approved by ATE, to Operator
- Operator reviews for pass/fail, issues Type Approval certificate
- Manufacturer is free to submit Data Package to other operators. No repeated testing is required.

On-site testing is difficult at Ka-band

- Spacecraft inclination causes pattern measurement distortion and gain mis-calibration for larger antennas
- Scintillation adds noise to pattern measurements
- Atmospheric loss variations degrade gain calibration
- Rain and ice along path degrade cross-polarization measurement
- OBP payloads may not support transmit tests... at all
- ***Ka-band increases the important of type approvals***



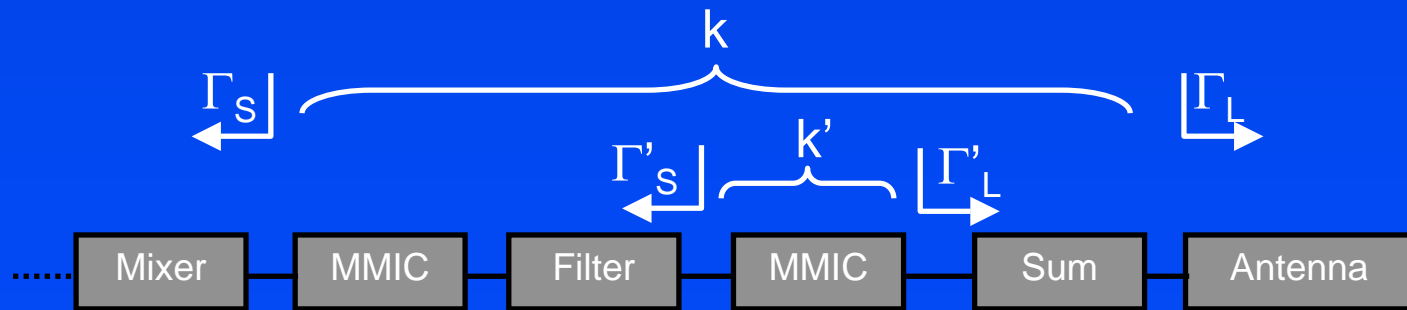
Ka-band Range Measurement Issues

- Wet antenna effect.
What are the test conditions?
How to calibrate?
Where to put the source?
- Pointing accuracy and stability.
How to qualify and calibrate range for absolute boresight angle measurements?
- Axial ratio (cross-pol discrimination in circular pol system).
How to realize extreme CP purity in source antenna?
Alternative calibration techniques?
- Beam squint (boresight difference between LHCP and RHCP signals)
How to calibrate range boresight for wide frequency separation?



Ka-band electronics measurement issues

- Uplink power control algorithms
 - Standard fade event profile?
 - Uniform test procedure for diverse techniques?
- Stability
 - Rollette stability factor k' of each active stage, vs. k for complete SSPA
 - Varies with device lot/wafer
 - Varies with assembly technique



What needs to be done

- Refine GVF-101 for Ka-band issues
 - GVF-101 is the type approval procedure
 - Presently written in context of C- and Ku-band issues
 - Needs to address new issues raised by Ka-band
- Convergence of performance standards for Ka-band
 - GVF-102 is a standards survey; does not address Ka-band
 - Increase liaison with ETSI
 - Technical forum with Ka satellite operators
 - Ensure consistency with ITU & regulator requirements
 - But... must avoid simply compiling the worst cases of all standards!

In conclusion:

- For the success of Ka band, ground equipment must go direct from factory to field
- Operator Type Approvals are the key to protecting the arc and spectrum
- Now is the time to converge standards for interference prevention at Ka-band
- To participate:
 - All conference attendees are invited to attend the GVF-MRA WG mini-meeting, 14:30, Friday Sept 27.
 - Contact Global VSAT Forum:
 - **Website: www.gvf.org**
 - Current MRA procedure (GVF-101 rev C) is posted.
 - MRA working group contact:
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