

# Earth-Satellite Propagation Modelling

## Background and challenges

### Channel Impairments Earth-Satellite Propagation at Ka-band (20 GHz) and above is impaired by the Troposphere

- **Attenuation:** SNR reduction due to absorption and scattering by hydrometeors and gases;
- **Depolarization:** interference in polarization re-use due to ice clouds and rain drops;
- **Scintillation:** low fade margin systems compromising due to refractive index fluctuations;

### Ka and Q/V bands Future Satellite Telecommunications Systems using more and more Ka and Q/V bands offer new opportunities but also several limitations

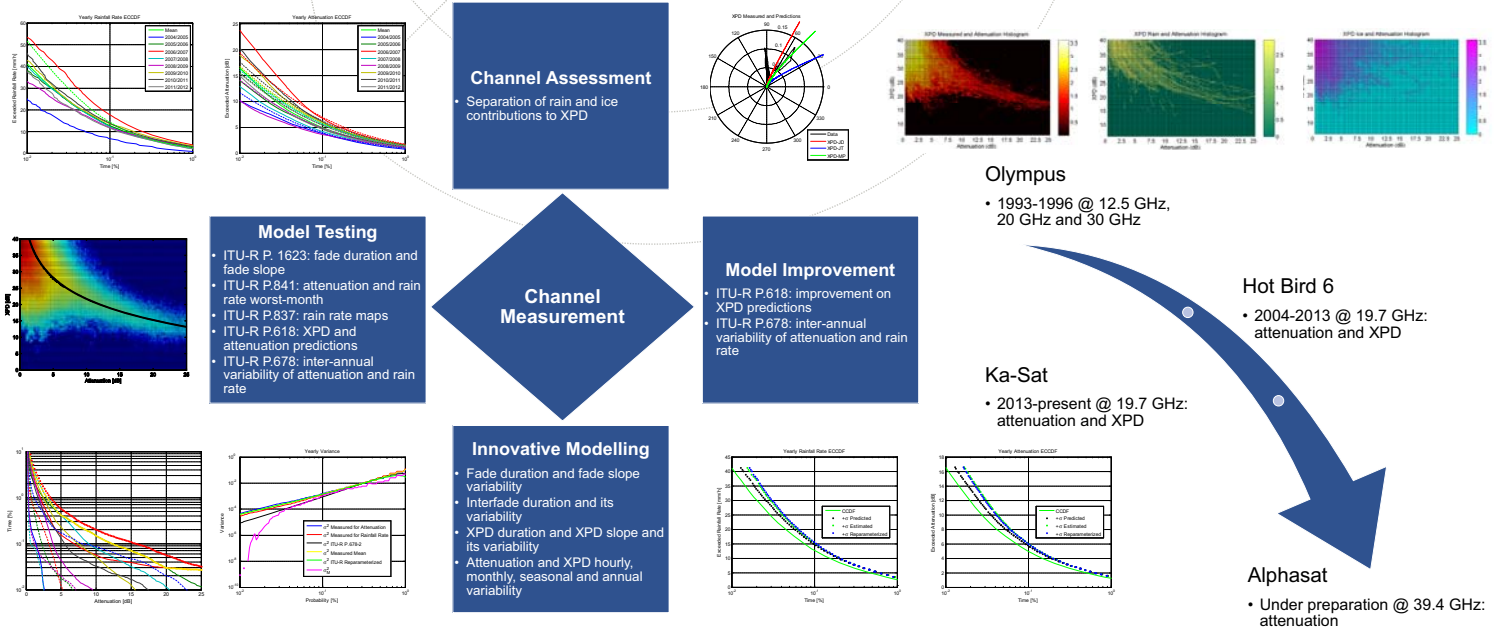
- Very large bandwidth and capacity;
- Less interference;
- Increased impairments, mainly attenuation: not enough fade margins for adequate QoS;

### PIMTs Design, implementation and test of Propagation Impairment Mitigation Techniques require new models concerning channel dynamic aspects

- Fade duration/return (engagement of resources) and fade slope (design power control loops);
- Time and space fade correlation over large areas (power redistribution) and time/space diversity;
- Better understanding of XPD physical contributions (rain/ice) and frequency attenuation scaling;



## Description and main innovation



## Achievements

|                                                                                                                                                           |                                                                                                                                                                               |                                                                                                                                                                            |                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                   |
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| <p><b>Space Propagation Campaign</b></p> <ul style="list-style-type: none"> <li>• The longest ever undertaken in the world @ Ka-Band: 10 years</li> </ul> | <p><b>ITU SG3 Database Contributions</b></p> <ul style="list-style-type: none"> <li>• Attenuation and rain rate: 7 years</li> <li>• Sky noise temperature: 3 years</li> </ul> | <p><b>International Cooperation</b></p> <ul style="list-style-type: none"> <li>• ETSI-Madrid (Spain)</li> <li>• U-Vigo (Spain)</li> <li>• PoliMi, Milan (Italy)</li> </ul> | <p><b>International Projects</b></p> <ul style="list-style-type: none"> <li>• ESA study No.4000107135/12/NL/LvH: Development of High Order Propagation Models for Multimedia Satellite Communication Systems</li> <li>• One proposal pending</li> </ul> | <p><b>Other Contributions</b></p> <ul style="list-style-type: none"> <li>• 3 journal papers</li> <li>• &gt;15 conference papers</li> <li>• 1 PhD Thesis (on going)</li> <li>• 10 MSc Thesis</li> <li>• 1 graduation report</li> <li>• COST IC0802 report contributions</li> </ul> |
| <p><b>ITU-R Evaluation and Improvements Proposal</b></p>                                                                                                  | <p><b>A Novel Method to Assess Physical Channel Properties</b></p>                                                                                                            |                                                                                                                                                                            |                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                   |

