UN/CROATIA WORKSHOP ON GNSS APPLICATIONS
Baška, Krk Island, Croatia, 21 - 25 April, 2013

GNSS SPACE WEATHER RESILIENCE SCHEME

RENATO FILJAR, Faculty of Maritime Studies, University of Rijeka, Croatia
• Content

– Space weather effects on GNSS
– General GNSS resilience scheme
– Technology advancements
– Risk assessment
– Space weather monitoring
– Corrective actions
– Alerts and forecasts
– Division of responsibilities and liabilities
– Conclusion
– References
• Space weather effects on GNSS

  – Space weather effects on GNSS performance
    • Accuracy deterioration
    • Reduced availability
    • Embedded corrective activities not tailored for the situation

  – Space weather effects on GNSS operation
    • Surface and deep dielectric charging
    • Single event upsets
    • Spacecraft drags
    • Accumulating dose effects
    • Photonic noise
    • Materials degradation
General GNSS resilience scheme

- **Preparatory Segment**
  - Threats Identification
  - Risk Assessment for Technology and Business Processes

- **Monitoring Segment**
  - GNSS Performance and Operation, and Positioning Environment Monitoring

- **Operational Segment**
  - Alerts
  - Corrective Actions

- **Identification of Risk Environment**
  - Monitoring the effectiveness of risk assessment scheme

- **Assessing the Probability of Risk Event Occurrence**

- **Preparing the Response to Risk Events**

- **Activate the System to Deal with Risk Event Occurrence**

- Infrastructure Protection
- Restriction or Temporal Suspension of Services
Technology advancements

- Advanced error (ionospheric delay) correction models
- Assisting and augmenting systems (DGPS, SBAAS/EGNOS/WAAS, A-GNSS)
- Advanced utilisation of statistical signal processing and Bayesian modelling
- Positioning sensor fusion
- Combined positioning systems (i.e. GNSS + INS + map matching)
- Utilisation of advanced GNSS receiver techniques and architectures (software-defined and cognitive radio, distributed architectures, cloud computing)
• Risk assessment

  - End-users of GNSS and GNSS-based systems and services should perform a pre-assessment of the effects of space weather-initiated effects on their systems, services, operation and internal business processes

  - This pre-assessment is to be made by experienced GNSS and risk management specialists
• Space weather monitoring

  – Continuous space weather and ionospheric dynamics monitoring

  – Complex and expensive systems vs fairly distributed network of low-cost sensors of ionospheric activity
• Corrective actions

  – Putting in operation the alternative procedures to sustain business processes

  – Mitigation techniques to minimise the effects of influencing processes and variables
• Space weather alerts and forecasts
  – Based on the analysis of GNSS and space weather data, and the risk assessment of the potential GNSS threats, operations and performance deterioration
  – Alerts to general public and targeted groups of GNSS users
  – Forecasts of probability of GNSS-related events
  – Already available: NOAA USA OMA (European Union), www.ionosphere.hr (Faculty of Maritime Studies in Rijeka, Croatia),
Division of responsibilities

- GNSS operators – core system operation, global assistance and augmentation, global ionospheric and the other natural effects

- National governments – GNSS signal and spectrum protection on national level, combating local jamming and spoofing, regulating service provision, space weather monitoring
• Division of responsibilities

  - Service providers – proper usage of standardised equipment, combating user-initiated jamming, targeted GNSS performance deterioration alerts, service provision risk assessment

  - End users - responsible and honest use of GNSS-based systems and services
• Conclusion

• GNSS as a part of national infrastructure
• Growing number of technology- and socio-economic systems rely upon GNSS
• Space weather and ionospheric dynamics - the single major cause of GNSS performance deterioration and potential temporal outages
• Understanding of space weather and ionospheric effects on GNSS performance and operation-essential for building robust satellite systems and provision of seamless and high-quality GNSS-based services
• Conclusion

New GNSS-related jobs to be created: space weather forecaster, GNSS performance specialist, GNSS space weather risk specialist, GNSS application developer, GNSS-specialised solicitor/lawyer, GNSS-based development strategist
• **References**


THANK YOU FOR YOUR ATTENTION!

Dr Renato Filjar, FRIN
Associate Professor
E-mail: renato.filjar@gmail.com