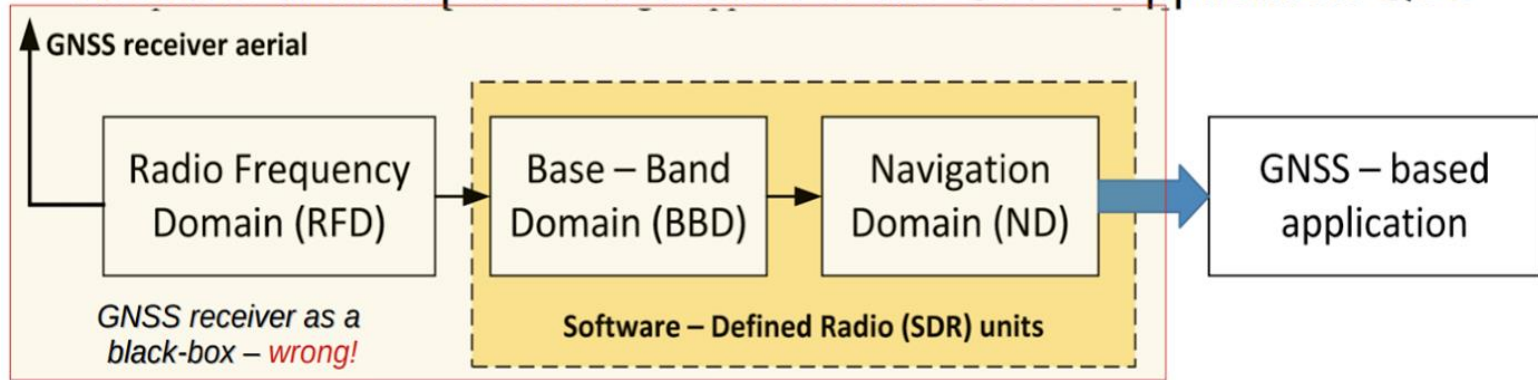


INFORMATION REINFORCEMENT FOR GNSS RESILIENCE

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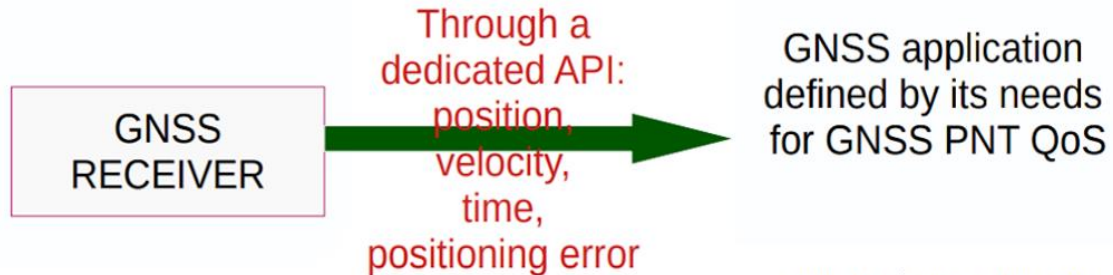
FINDING

- A traditional GNSS application model
- **Unnecessary equivalence between a GNSS receiver and a GNSS position estimation process/algorithm** as a considerable obstacle in transparent definition of the GNSS application QoS



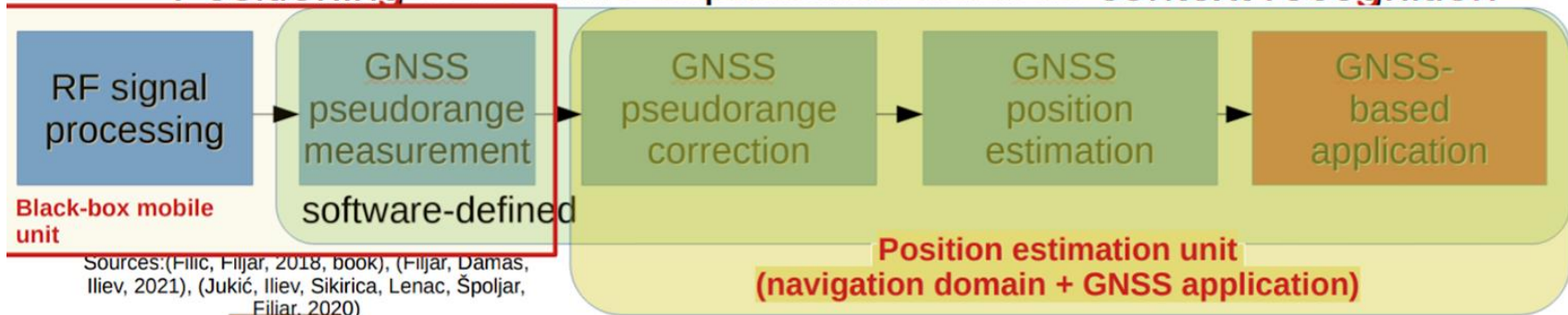
GNSS system

Source:(Filić, Filjar, 2018, book), (Filić, Filjar, 2018, MIPRO), (Filić, Filjar, 2018, ION GNSS+ 2018)



Source:(Filić, Filjar, 2018, book)

- Positioning environment-adaptive GNSS position estimation algorithm integrated with the GNSS application
- **GNSS application** manages **autonomously** the QoS (selection of suitable GNSS position estimation method and error correction procedures based on real-time positioning environment conditions, scalable GNSS positioning performance)
- **GNSS operator** remains responsible for the matters of GNSS spectrum and signals
- **Positioning** to become expandable towards **context recognition**



Finding

- + Adversarial natural (space weather, geomagnetic, ionospheric, multipath, tropospheric) and artificial (spoofing and meaconing) effects on GPS positioning performance are evident in navigation domain as corrupted information
- + Opportunity to mitigate and overcome them, thus improving GPS performance, in the Software-Defined Radio-based position estimation process (application oriented spoofing detection, statistical learning-based ionospheric corrections in real positioning environment conditions)
- + Bespoke statistical learning ionospheric correction models based on real environment geomagnetic field observations -> an alternative to Klobuchar model

Recommendation

Recommendation

- + To establish a standardised real-time IP streaming service of broadcast navigation message to allow for detection of classes of spoofing attacks in the navigation domain/position estimation process
- + To establish a standardised real-time IP streaming service of geomagnetic conditions data to allow for tailored ionospheric effects corrections in the immediate vicinity of a rover

- + Operation: USAF, NOAA, NASA (content/data providers), NASA? (service provider)

Reasons for recommendation

Reasons for recommendation

- + (1) Reinforcement of the GPS information content
- + (2) Framework foundation for more efficient tailored/personalised mitigation of ionospheric effects in the actual positioning environment conditions
- + (3) Detection and mitigation of classes of GPS spoofing attacks
- + (4) Enhancement of the core GPS infrastructure
- + (5) Provision of trusted and reliable GPS positioning-related information without the need for a costly additional infrastructure
- + (6) Facilitation of GPS application development that focuses on the QoS requirements
- + (7) GPS operator is revealed from the mission impossible to assess and guarantee over-all positioning performance without control of the entire positioning environment

Consequences of no action

Consequences of no action

- + (1) Status quo remains
- + (2) GPS position estimation process remains vulnerable to information-side (cyber) attacks
- + (3) GPS position estimation process deprived from active contribution to adverse effects mitigation
- + (4) Application development opportunities are unnecessarily constrained