

IEEE Synthetic Aperture Radar Standards Committee

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IEEE Standards

- ◆ An IEEE standard is a document established by consensus that provides rules, guidelines, or best practices for salient technical aspects of SAR. It is a basis for comparison and a reference point against which other approaches, designs or algorithms can be evaluated.
- ◆ After publication, a well-written standard establishes uniform engineering or technical criteria, methods, processes, and practices.

Synthetic Aperture Standard Committee

- ◆ There is a recognition that across a variety of disciplines common theoretical, mathematical, and algorithmic techniques are employed:
 - ✦ Synthetic Aperture Radar
 - ✦ Synthetic Aperture Sonar
 - ✦ Synthetic Aperture Channel Sounding
 - ✦ Fourier Ptycography
 - ✦ Event Horizon Telescope
 - ✦ Medical Imaging

- ◆ The goal of the SASC is to establish IEEE Standards for each of these application areas while taking into account the common threads underlying these:
 - ✦ Data acquisition
 - ✦ Processing
 - ✦ Analysis and interpretation

Motivation for SAR Standards

- ◆ SAR is increasing being used in space-based and automotive radar applications. Having a uniform set of standards can enable system interoperability
- ◆ Standards can establish best practices and rules-of-thumb for implementing SAR algorithms in a broad range of applications
- ◆ Our interpretation of “SAR” is very broad; encompasses:
 - ✦ Standard SAR
 - ✦ Inverse SAR (ISAR)
 - ✦ Interferometric SAR/ISAR
 - ✦ Polarimetric SAR/ISAR
 - ✦ Multichannel Radar
 - ✦ Multistatic Radar
 - ✦ MIMO Radar
 - ✦ Distributed radars
- ◆ Aspects for standardization:
 - ✦ Standard processing structures and algorithms (both hardware and software implementations)
 - ✦ Testing and benchmarking mechanisms
 - ✦ Waveforms
 - ✦ Operation across frequency bands
 - ✦ Synchronization of radars (for Multistatic operation)
 - ✦ Antenna spacing
 - ✦ Sampling
 - ✦ SAR/ISAR image quality assessment
 - ✦ SAR/ISAR image interpretation
 - ✦ SAR/ISAR image fusion (across aspects, frequency bands)

SICD and SIDD: SAR Data Formatting Standards

- ◆ SICD (Sensor Independent Complex Data) is a SAR data formatting standard that has been developed “to store and transmit complex image products from a wide range of SAR sensors and data processing systems. A SICD product contains the complex image pixel data and a set of metadata describing both the radar collection and the image formation processing.”
 - ✦ The “sensor independence” of the SICD product refers to the ability of the allowed pixel array and metadata options to accurately describe the image products from many sensors and data processing systems.
 - ✦ Sensor independence does NOT mean that all products have the same format for the pixel array or the same set of metadata parameters.
- ◆ SIDD (Sensor Independent Derived Data) is a SAR data format is designed to store Synthetic Aperture Radar (SAR) derived-image products and their associated metadata, which is grouped around common tasks for downstream users.
- ◆ SICD and SIDD are emerging as important SAR data formats
 - ✦ A possible strategy would therefore be to build upon these standards (SICD and SIDD) to suite the purposes of our broader SAR standardization efforts.

Sub-groups for IEEE SAR SA

- ◆ We recommend forming different sub-groups that will be in charge of standardizing different aspects of the IEEE SAR SA standard. Following are some suggested sub-groups:
 - ✦ Basic SAR processing sub-group: SAR, ISAR, InSAR, InISAR, Pol-SAR, Pol-ISAR
 - ✦ Autofocusing and Calibration sub-group
 - ✦ Multichannel SAR sub-group: Co-located MIMO radars
 - ✦ Multistatic SAR sub-group: Distributed MIMO radars
 - ✦ Maritime SAR sub-group:
 - Proposed Lead of Maritime SAR sub-group: Dr. Ralph Fiedler
 - ✦ SAR image quality and image interpretation sub-group
 - ✦ Solopulse sub-group
 - ✦ Industry Focus#1:Automotive SAR sub-group
 - ✦ Industry Focus#2: Space-based SAR sub-group
- ◆ Participation in various sub-groups requested based on interest and expertise
 - ✦ Volunteers for leading/co-leading various sub-groups
 - ✦ Volunteers for participation in sub-groups

Sub-groups for IEEE SAR SA (2)

- ◆ 6 months to develop a recommendation to the IEEE SA
 - ✦ Possible extension of 6 more months to develop recommendation
- ◆ Once our RSG recommendation is approved, we will have **4 years** to develop the full IEEE SAR Standard – possibly separate standard document for each identified sub-group (which will be coalesced into the overall SAR standard)
- ◆ Suggestions for new/reorganized sub-groups?
 - ✦ Discussion: Grouping some of the sub-groups wherever possible
- ◆ Discussion: SICD and SIDD as a starting point to build upon for the various sub-groups

1. Called to Order at 12:00 p.m. ET
2. Introductions and [Employer/Affiliation Declarations](#)
 - a. Verbal introductions and statement of affiliations made and [captured](#).
3. Review PAR Study Group Scope and Operations
 - a. See [SPS SASC Clause 5.5 PAR Study Group](#)
4. Motion #1: Approval of [Agenda](#)
 - a. Moved by: Bradley Evans (UNM)
 - b. Seconded by: Brian Sequeira (Johns Hopkins)
 - c. Discussion: No discussion
 - d. Result of the vote: Unanimously Approved
5. IEEE Policies Review, Presentations shared by Johnathan Goldberg, IEEE
 - a. [IEEE Patent Presentation for Pre-PAR Activities](#)
 - b. [IEEE SA Copyright Policy](#)
 - c. [IEEE SA Participation](#)
6. [Presentations](#) or Discussions
 - a. Introduction to SAR SG: Dr. Raghu G. Raj (NRL)
 - b. SICD and SIDD Standards Overview: Dr. Ralph Fiedler (NRL)/Dr. Robert Jansen (NRL)
 - c. SAR SG Sub-group formation: Dr. Raghu G. Raj (NRL)
 - i. Members discussed differences between each of the presented subgroups
 - ii. Additional subgroups proposed
 1. Polarimetric SAR, Stephano Tebaldini (Politecnico di Milano), question of appropriateness to SPS
 2. Tomographic SAR, Stephano Tebaldini (Politecnico di Milano), question of appropriateness to SPS
 3. Advanced SAR processing, Jeff Arndt (KBR)
 - d. Conclusion: Dr. Kumar Vijay Mishra (ARL)
7. Old Business
 - a. Virtual Workshop: Call for Speakers - timeframe of Fall
8. New Business
 - a. No new business
9. Future Meetings
 - a. 1 June 2022 @ 12:00 p.m. ET
 - b. Will continue discussion of sub-groups at next meeting

BACKUP

Synthetic Aperture Radar: New Developments

• Fundamentals

- Requirements to avoid spatial and temporal aliasing
- Broad Areas: SAR, ISAR, InSAR, circular SAR, polarimetric SAR, SLAR, passive SAR, tomographic SAR

• Inverse Problems

- New autofocusing algorithms
- Sparse sampling approaches
- 3D Reconstruction
- Deconvolution
- Super-resolution
- Wideband

• Machine Learning

- Supervised and unsupervised learning
- Deep learning (CNN, LSTM)
- Reinforcement learning, Q-learning
- Generative models
- Transfer learning

• New Optimization Approaches

- Low-rank models
- Tensor processing
- Novel waveform designs
- Image denoising
- Graph-based approaches

• Unconventional Geometries

- FLoSAR
- Intelligent surfaces
- Bistatic SAR
- Distributed SAR
- Wide-angle SAR

• Unconventional Frequencies

- mm-Wave SAR
- sub-THz SAR

• Novel Applications

- Automotive SAR
- Spectrum-sharing
- Cognitive SAR
- MIMO-SAR
- Drone/UAV-borne SAR