Considerations towards the Future of Space-borne SAR Systems

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Future SAR systems in effect have to be smaller, simpler and cheaper than the present systems like ENVISAT/ASAR and RadarSAT 1. They must be easy to handle and have to deliver dedicated information in real time to each special user in economically usable product form. Therefore, both the application requirements of the user and the expected progress of technique and technology and economical facts dictate the future of SAR systems. However, there are requirements for higher resolution, wider swaths, space-borne MTI capability, high repetition rates up to permanent coverage, drastic reduction of mass, volume and power consumption to about 2 orders of magnitude, and autonomous control and operation of spacecraft as well as the realization of onboard data analysis and feature extraction. All these requirements are to a wide sense contra dictionary. Goal of the presentation is to point out expectations and perspectives for future SAR techniques, technologies, and systems based on the status quo represented mainly by systems which are presently under development like TerraSAR, RadarSAT 2, SAR-Lupe and ALOS. However, the most modern and progressive space-borne system ever flown was the SRTM (2001).

Basis for future SAR systems are novel techniques, technologies and system principles, which presently research topics like polarimetric interferometry, tomography, moving target indication from satellites, digital beam-forming, bi- and multi-static principles for example. Some respective results will be presented.

The most important Hardware component for SAR is the antenna. Future SAR mainly, will consist of the antenna with a small number of more ore less peripheral elements only (solar cells, GPS, power supply etc.). The present SAR Antenna mutates to a complete Antenna SAR. Digital Beam Forming (DBF) will become essential.

The so called “Moore’s Law” gives a macro trend of the progress in technology to be expected for the next Decades which enables a look into the future. The very new invention of the crossbar latch principle promises further validation of that law for the next decades even if the physical limits of transistor development will be reached within the near future.

Future SAR systems will be software based multi static systems characterized by multi-polarization and multi-frequency capability, and multiple operation modes as well. They will have one or more central illuminators together with a synchronized fleet of airborne, space borne, or ground based receivers which enable continuous availability with a nearly global coverage

This will be a SAR systems with wide angle beam illumination realized by highly efficient reflector antennas fed from high power microwave vacuum sources with high efficiency on the transmitter side and a fleet of space-borne and air-borne receiver which will be organized as an intercommunicative web. That is a macro instrument concept that allows for coordinated efforts between multiple numbers and types of sensing platforms, including both orbital and terrestrial both fixed and mobile. Information gathered by one sensor is shared and used by other sensors in the web. Each sensor communicates with its local neighbours and thus distributes information to the instrument as a whole. This web, principally, is an extremely large Phased Array DBF SAR where each receiver is an array element. A standardization of both frequencies and respective components will reduce the cost. A dual use of respective frequency bands should allow applying the same modules for both radar navigation and communication purposes.

The present communication and navigation systems have small and cheap user units (to a wide extent standardized) and more or less centralized transmitters. Hence, it is necessary to learn from these already existing systems and to take over respective technologies, techniques and even components. This predestinates in some cases the frequency range, L-Band for example, by using GPS ore GALIEO components as well for example.

The frequency allocation for reconnaissance and remote sensing purposes is one of the main future administrative problems also. The dual use of the same frequencies for radar and other services will be indispensable as well as design to cost and use of existing technologies, products and competence. This implies the need for use and application electronic components gained with other microwave communication and navigation programmes. Dual use for both, military and civil applications is strictly necessary also. Under economic aspects, a better relationship between investments and outcome should be reached and new applications have to be promoted. SAR has to deliver information not only images.

The expected development of technique and technology will lead within the next Decades to establishing an autonomous, global "Reconnaissance and Remote Sensing System" with integrated communication, positioning and navigation capability which has one or more central illuminators together with a synchronized fleet of both airborne and space-borne receivers which enable global coverage and continuous availability as mentioned above. A first major step could be the use of GPS ore Galileo satellites as transmitters which in a later step could be especially equipped (exemplary during maintenance and exchange) with dedicated wide band and high power SAR transmitters where the comparably small GPS bandwidth of 10 MHz is embedded. However, the latter is a vision for the far future.