6G-SKY

EUREKA-CELTIC- 6G-SKY: Technologien zur Vernetzung und Koordination des intermodalen Gu¨terverkehrs

Programm / Ausschreibung	Mobilität der Zukunft, Mobilität der Zukunft, MdZ M-EraNet Ausschreibung 2021	**Status**	laufend
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Projektbeschreibung

Die Digitalisierung entlang der Transportkette im intermodalen und kombinierten Verkehr (inkl. Schiene mit Vor-und Nachlauf) hat großes Potential, über einheitliche IT-gestützte Buchungssysteme, Prozesse durchgängig zu gestalten. Die Servicequalität des Systems (im Sinne von z.B. ETA-Garantien) kann dadurch erhöht werden. Gleichzeitig können modalitäts-übergreifende automatisierte Optimierungsverfahren Ressourcenverbrauch und Emissionen für einen nachhaltigeren und kostenschonenderen Betrieb reduzieren. Die Möglichkeit der Einbindung elektrischer/wasserstoffbetriebener autonomer Transportmittel in die letzte Meile unterstützt Klimaneutralität.
Jedoch ist die erforderliche Vernetzung des Gesamtssystems und seiner Komponenten derzeit noch ein fehlendes Bindeglied. Hier setzt 6G-SKY an. Es wird eine neuartige Kommunikationsarchitektur vorgeschlagen die die Vernetzung/Kommunikation zwischen Fahrzeugen und Infrastruktur auch im ländlichen/alpinen Raum deutlich verbessert und gleichzeitig Statusinformationen über den Verkehrszustand liefert. Die so generierten Informationen finden bei o.g. Optimierung des Mobilitätsystems Berücksichtigung.
Die dazu notwendige 6G-SKY-Kommunikationsarchitektur (siehe Kap 1.1) besteht aus einer Verknüpfung verschiedenster Funktechnologien und unterschiedlicher Trägersysteme zu Land (z.B. Mobilfunk) und in der Luft/im Weltraum (Satelliten, Flugzeuge, Drohnen (UAVs), etc.). Sie wird in Ihrer Gesamtheit zusammen mit EU-Partnern in einem Celtic-Projekt unter Führung von Airbus entwickelt. Das Celtic-Projekt wurde positiv bewertet (Celtic Label) allerdings gibt es auf Celtic-Ebene keine Förderung. Die Länderkonsortien müssen sich um nationale Förderungen bemühen. Der gegenständliche nationale Projektantrag 6G-SKY um das österreichische Konsortium entwickelt insbesondere die drohnen-basierte Ebene und wendet die neue 6G-SKY Architektur auf einen Anwendungsfall der Gütermobilität an (Koordination eines Logistik-Hubs zw. Schiene und Straße unter Einbindung autonomer Transportfahrzeuge) und profitiert von hochrangigem internationalen Know How.
Im Ensemble der 6G-SKY-Architektur fungiert ein Drohnenschwarm als flexibles Kommunikationsnetzwerk in einer dynamischen Mobilitätsumgebung und schafft Konnektivität zw. Fahrzeugen, Schienentransport und Infrastruktur auch in ländlicher Umgebung. Gleichzeitig generiert der Schwarm Verkehrszustandsinformationen in Echtzeit, die in einer zentralen Koordinationsinstanz dazu verwendet werden (autonome) Fahrzeuge zu koordinieren (mittels Ansätzen der Routenoptimierung und Schwarmintelligenz als Verfahren der KI).
6G-SKY entwickelt dafür die notwendigen Komponenten (Schwarmkoordinationsalgorithmen für UAVs und autonome

Fahrzeuge, schwarmfähige UAV-Hardware, Kommunikationstechnologien, Sensorik, Auswertungsmethoden, Routenplanung). Aus den Komponenten wird ein Systemdemonstrator aufgebaut, der sowohl im Umfeld der 6G-SKY Gesamtarchitektur (siehe Kap 1.1) mit den Celtic Partnern getestet, als auch in Österreich in Testlaboratorien am Beispiel der Gütermobilität in Demonstrationen einem Proof-of-Concept (PoC) Test zugeführt wird. Das Ergebnis dieses Projektes ist neben der Erbringung des Funktionsnachweises ein verfeinertes Konzept, F&E-Roadmaps und Verwertungsstrategien, die in Nachfolgeprojekten hin zu marktreifen Lösungen umgesetzt werden sollen.

Abstract

The digital tranfromation along the transport chain in intermodal and combined transport (including rail with pre- and post-carriage) has great potential to design processes seamlessly through uniform IT-supported booking systems. The service quality of the system (in the sense of e.g. ETA guarantees) can thereby be increased. At the same time, cross-modality, automated optimization processes can reduce resource consumption and emissions for more sustainable and cost-efficient operation. The possibility of integrating electric / hydrogen-powered autonomous means of transport into the last mile supports climate neutrality.

However, the necessary interconnection of the overall system and its components is currently still a missing link. This is where 6G-SKY comes in. A novel communication architecture is proposed which significantly improves the interconnection / communication between vehicles and infrastructure, even in rural / alpine areas, and at the same time provides status information about the traffic condition. The information generated in this way is taken into account in the aforementioned optimization of the mobility system.

The 6G-SKY communication architecture required for this (see Section 1.1) consists of a combination of various radio technologies and different carrier systems on land (e.g. cellular networks) and in the air/space (satellites, aircraft, drones (UAVs), etc.). It is being developed in its entirety together with EU partners in a Celtic project under the leadership of Airbus. The Celtic project was rated positively (Celtic Label), but there is no funding at Celtic level. The country consortia must seek national funding. The present national project application 6G-SKY by the Austrian consortium develops the drone-based level in particular and applies the new 6G-SKY architecture to an application of goods mobility (coordination of a logistics hub between rail and road with the involvement of autonomous transport vehicles) and benefits of high-level international know-how.

In the ensemble of the 6G-SKY architecture, a swarm of drones acts as a flexible communication network in an environment showing dynamic mobility and creates connectivity between vehicles, rail transport and infrastructure, even in rural areas. At the same time, the swarm generates traffic status information in real time, which is used in a central coordination instance to coordinate (autonomous) vehicles (using approaches of route optimization and swarm intelligence as methods from AI).

6G-SKY develops the necessary components for this (swarm coordination algorithms for UAVs and autonomous vehicles, swarm-capable UAV hardware, communication technologies, sensors, evaluation methods, route planning). A system demonstrator is built from the components, which is tested both in the context of the 6G-SKY overall architecture (see Section 1.1) with the Celtic partners, and in Austria in test laboratories demonstrating the example of goods mobility as a proof-of-concept (PoC) test. The result of this project is, in addition to providing proof of functionality, a refined concept, R&D roadmaps and exploitation strategies that are to be implemented in follow-up projects to create market-ready solutions.

Endberichtkurzfassung

The 6G-SKY project (“6G for Connected Sky”), bringing together Austrian and European partners from Germany, Sweden and

Hungary, developed the concept of a Combined Airspace and Non-Terrestrial Networks (Combined ASN) for future 6G networks, which integrates terrestrial, aerial (like drones and HAPs), and satellite (non-terrestrial) networks into a single, three-dimensional communication system. The goal was to provide reliable, high-capacity connectivity for both aerial and ground-based users, supporting advanced applications such as urban air mobility, logistics and smart city services by creating a holistic, adaptive, and flexible multi-layered network architecture. The project also carried out important work, including experiments and demonstrations, to inform standardization activities and provide guidance for future regulation.

One of the major milestones of the project was the successful testing of drone swarms in a real-world environment at the logistics hub LCA Süd in Fürnitz. In these demonstrations, drones collaborated to identify and track containers on the ground and to support autonomous mobility. These field trials showed how multiple drones can work together effectively, opening up possibilities for smarter, more flexible operations in logistics centers and similar settings.

The project's achievements were recognized at the international level. During its final review by the CELTIC-NEXT program at Airbus in Germany, 6G-SKY received the best possible grade of "Excellent" . This was a strong endorsement of the scientific, technical, and collaborative results achieved by the consortium.

Behind these demonstrations stood important innovations. 6G-SKY developed new algorithms that allow drones to cooperate without needing a central controller, reducing mission times by up to 40% compared to traditional centralized approaches. Communication modules that combine terrestrial and satellite connectivity were designed and tested, making drone swarms more robust and reliable. To support these advances, a customized drone platform was built, carrying high-resolution cameras and communication equipment. These cameras enabled the drones to recognize container labels and perform object detection.

Beyond the technical work, 6G-SKY reached out to both the scientific community and the wider public. The drone platform was showcased at the Mobile World Congress 2024 in Barcelona, the world's largest mobile technology fair, attracting the attention of more than 100,000 visitors. The project also gained visibility in Austria when its logistics use case was featured on national television. On the academic side, the consortium published several scientific papers, including a joint vision paper that attracted international recognition, with further publications expected.

Projektkoordinator

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Projektpartner

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