Workshop (Special Session) on "Semantic and Goal-Oriented Communication for 6G: Architectures, Evaluation, and Emerging Applications"

Workshop (Special Session) co-Chairs:

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Brief description

This session brings together five complementary presentations that explore the emerging paradigm of semantic and goal-oriented communication as a cornerstone of future 6G networks. Moving beyond traditional bit-centric communication models, the session highlights how task relevance, context awareness, and shared intent can fundamentally reshape network design, control, and performance evaluation. The talks collectively address key dimensions of this transformation, including semantic-aware O-RAN architectures, AI-native network design, and integration across terrestrial and non-terrestrial networks. They also examine foundational concepts such as goal-oriented communication in multi-agent systems, emphasizing the role of efficient information exchange under resource constraints. From an evaluation perspective, the session introduces novel semantic-aware KPIs and cross-layer metrics that jointly capture communication, computation, and application performance, offering new insights into network optimization. Finally, practical aspects are covered through distributed sensing frameworks and real-world demonstrators, showcasing how semantic intelligence can enable cooperative perception and advanced services in complex environments. Overall, the session provides a holistic view of how semantic and goal-oriented principles can drive the evolution toward adaptive, intelligent, and efficient 6G systems.

Title: Semantic and Goal-Oriented O-RAN for 6G: From Architecture to Evaluation and Network-Level Insights.

This presentation explores a semantic and goal-oriented extension of O-RAN architectures within the 6G-GOALS framework, with a focus on the practical evaluation of semantic communication systems and their potential to provide actionable insights for designing adaptive, efficient, and interoperable 6G networks. The talk introduces mechanisms to integrate semantic awareness into RAN control loops through enhanced intelligent controllers, AI-driven models, and new or extended interfaces that enable interaction between user devices, applications, and network entities. Beyond architectural aspects, the presentation highlights key challenges such as model interoperability, semantic alignment across heterogeneous systems, and the need for continuous learning and feedback. It also discusses novel evaluation perspectives, including semantic-aware KPIs and goal-oriented metrics that jointly capture communication, computation, and application performance, emphasizing the importance of cross-layer optimization in future 6G networks.

Title: Toward Goal-Oriented Communication in Multi-Agent Systems: An overview.

As multi-agent systems (MAS) become increasingly prevalent in autonomous systems, distributed control, and edge intelligence, efficient communication under resource constraints has emerged as a critical challenge. Traditional communication paradigms often emphasize message fidelity or bandwidth

optimization, overlooking the task relevance of the exchanged information. In contrast, goal-oriented communication prioritizes the importance of information with respect to the agents' shared objectives. This overview aims to provide a perspective on goal-oriented communication in MAS, bridging perspectives from control theory

Title: Semantic aware ORAN UNITY-6G Architecture framework for integrated TN-NTN networks.
We propose a semantic-aware O-RAN UNITY-6G architecture that prioritizes the transmission of meaningful information rather than raw data. The framework enables adaptive integration of TN-NTN environments and introduces semantic-aware resource optimization. It also incorporates an AI-driven closed-loop control mechanism for real-time and efficient network management. Overall, the proposed approach improves latency, enhances energy efficiency, and boosts overall system performance, making it a strong candidate for future 6G networks.

Title: Architectural Implications of Semantic and Goal-Oriented Communications in AI-Native 6G: A 6GARROW Perspective.
This presentation examines how semantic and goal-oriented communications may influence the design of AI-native 6G architectures, using the 6GARROW architectural framework as a reference point. The central argument is that once communication is driven not only by reliable bit delivery, but also by task relevance, intent fulfilment, and context awareness, its implications extend beyond the physical and protocol layers into the architectural design of the network itself. In this perspective, semantic and goal-oriented operation motivates new architectural capabilities such as semantic representations, intent-driven orchestration, enhanced analytics, semantic-aware edge inference, and extensions to conventional QoS frameworks toward predictive and semantic service descriptors. The talk discusses how these ideas interact with RAN-Core integration, O-RAN control structures, AI model lifecycle management, and digital twin based closed-loop operation, and highlights the main research and standardization questions that arise when moving from conventional communication paradigms toward semantically aware 6G systems.

Title: Distributed Semantic Intelligence for 6G Sensing: from architecture to real-world demonstrators.
This presentation introduces the Distributed Intelligent Sensing and Communication (DISAC) framework as a key enabler for next-generation 6G systems, addressing the limitations of centralized Integrated Sensing and Communication (ISAC) architectures. The talk will provide a comprehensive overview of the DISAC architecture, highlighting its hierarchical and distributed design that pushes sensing, processing, and intelligence to the network edge while maintaining coordinated global orchestration. Particular emphasis will be placed on the novel semantic plane, which enables goal-oriented multi-modal data fusion, and to on distributed protocols and orchestration mechanisms. Finally, the session will showcase a proof-of-concept demonstrator in an assisted parking scenario, illustrating how DISAC enables cooperative perception and autonomous navigation in complex, GNSS-denied environments.

Possible Panel discussion (after the presentations)
Title: ***Toward Semantic-Native 6G Networks: Architectural Evolution, AI integration and the Path to Standardization.***

Potential support
The session is supported by SNS JU projects 6G-GOALS, 6G-LEADER, UNITY-6G, 6G-ARROW and 6G-DISAC.

History of the proposed Workshop/Special Session (if applicable)
The workshop in this format is a new initiative.

Short (150-200 words) bio of the co-Chairs

co-Chair 1 Short bio: Francesca Costanzo is a research scientist in Wireless Communication Systems

at CEA Leti Grenoble, France. Her research interests lie in the area of B5G/6G systems, goal-oriented communications, edge intelligence and ISAC. She currently serves as deputy coordinator in the SNS JU projects 6G-GOALS and 6G-DISAC.
co-Chair 2 Short bio: **Themistoklis Charalambous** is a tenure-track Assistant Professor at the Department of Electrical and Computer Engineering, University of Cyprus. His primary research targets the design and analysis of (wireless) networked control systems that are stable, scalable and energy efficient. He currently serves as Technical Manager for the SNS JU project 6G-LEADER.
co-Chair 3 Short bio: **Luis Blanco** is a Senior Researcher at the Centre Tecnologic ´ de Telecomunicacions de Catalunya (CTTC). His research interests include optimization and artificial intelligence (AI) for wireless communication systems in beyond 5G and 6G integrated networks. He is the Scientific Manager of the HE-SNS Project UNITY-6G and leads the AI-based RIC activities in 5G-STARDUST.
co-Chair 4 Short bio: **Riku Jäntti** is a Full Professor of Communications Engineering at Aalto University School of Electrical Engineering, Finland. His research interests include low-power wireless systems, machine type communications, Cloud based Radio Access Networks, spectrum and co-existence management, quantum communications and RF Inference. He now serves as Technical Manager of the SNS JU project 6G-ARROW.