UNIVERSITÀ DI PISA

DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

Dottorato di Ricerca in Ingegneria dell'Informazione

Doctoral Course

"6G, Metaverse, and Generative AI: From Convergence to Emergence"

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Short Abstract:

6G will not be a mere exploration of more spectrum at high-frequency THz bands, but it will rather be a convergence of upcoming technological trends for stimulating more out-of-the-box research around 6G. While traditional applications will remain central to 6G, the key determinants of the system performance of future mobile networks will be new application domains such as multisensory extended reality (XR) applications, connected robotics and autonomous systems, human-machine interaction (HMI), as well as blockchain and distributed ledger technologies. Furthermore, haptic and empathic communications and the emergence of new human-centric service classes will lie at the heart of the coming 6G post-smartphone era. While smartphones were central to 4G and 5G, there has been an increase in wearable devices whose functionalities are gradually replacing those of smartphones, fueled by applications such as XR and HMI.

With the mass digital adoption of remote work and online social activities accelerated by a global pandemic, we may finally find ourselves on the verge of something big and potentially paradigm-shifting: The Metaverse – the next step after the Internet, similar to how the mobile Internet expanded and enhanced the early Internet in the 1990s and 2000s. The Metaverse, underpinned by decentralized Web3 technology, will be about being inside the Internet rather than simply looking at it from a phone or computer screen. It will surround us and will radically reshape society by realizing the fusion of digital and real worlds across all dimensions created and delivered by non-traditional converged service platforms of future 6G and Next G networks, where developers do not hesitate to use technologies from as many disciplines as possible. The Metaverse is widely seen as the precursor of the Multiverse. While the Metaverse primarily focuses on virtual reality (VR) and augmented reality (AR), the Multiverse offers eight advanced types of XR realms, which together span the entire reality-virtuality continuum, including but not limited to VR and AR.

This course aims at providing the attendants with new cross-disciplinary research material ranging from communication and computer science to cognitive science, social sciences, and behavioral economics. Among others, it reviews 6G paradigm shifts and elaborates on the difference between 6G and Next G research, including Next G Alliance's audacious goals and their symbiotic relationship

between technology and a population's societal and economic needs. It doubles down on the mutually beneficial symbiosis between digitalization and biologization for the emerging Industry 5.0 as well as for our possible evolution into future metahumans in a stigmergy-enhanced Society 5.0 by leveraging on time-tested self-organization mechanisms borrowed from nature, benefitting from not only emerging generative AIs but also nature's more-than-human intelligence.

Course Contents in brief:

- 6G Vision
- Immersive Tactile Internet Experiences via Edge Intelligence
- Context- and Self-Awareness for Human-Agent-Robot Task Coordination
- Cooperative Computation Offloading in FiWi-Enhanced Mobile Networks
- Decentralization via Blockchain
- XR in the 6G Post-Smartphone Era
- Metaverse: The New North Star
- The Multiverse: Infinite Possibility
- Beyond 6G: Next G Research
- Web3 and Token Engineering
- From Robonomics to Tokenomics
- Society 5.0: Internet as if People Mattered
- INTERBEING: Symbiosis between INTERnet and Human BEING in the Era of Generative AI
- Metahuman: Unleashing the Infinite Potential of Humans

Total # of hours of lecture: 20 hours (5 credits)

References:

[1] Amin Ebrahimzadeh and Martin Maier, "Toward 6G: A New Era of Convergence," Wiley-IEEE Press, January 2021.

[2] Martin Maier, "6G and Onward to Next G: The Road to the Multiverse," Wiley-IEEE Press, February 2023.

CV of the Teacher

Martin Maier is a full professor with the Institut National de la Recherche Scientifique (INRS), Montréal, Canada. He was educated at the Technical University of Berlin, Germany, and received MSc and PhD degrees both with distinctions (summa cum laude) in 1998 and 2003, respectively. In 2003, he was a postdoc fellow at the Massachusetts Institute of Technology (MIT), Cambridge, MA. He was a visiting professor at Stanford University, Stanford, CA, 2006 through 2007. He was a co-recipient of the 2009 IEEE Communications Society Best Tutorial Paper Award. Further, he was a Marie Curie IIF Fellow of the European Commission from 2014 through 2015. In 2017, he received the Friedrich Wilhelm Bessel Research Award from the Alexander von Humboldt (AvH) Foundation in recognition of his accomplishments in research on FiWi-enhanced mobile networks. In 2017, he was named one of the three most promising scientists in the category "Contribution to a better society" of the Marie Skłodowska-Curie Actions (MSCA) 2017 Prize Award of the European Commission. In 2019/2020, he held a UC3M-Banco de Santander Excellence Chair at Universidad Carlos III de Madrid (UC3M), Madrid, Spain. Recently, in December 2023, he was awarded with the 2023 Technical Achievement Award of the IEEE Communication Society (ComSoc) Tactile Internet Technical Committee for his contribution on the 6G and Tactile Internet integration. He is co-author of the book "Toward 6G: A New Era of Convergence" (Wiley-IEEE Press, January 2021) and author of the sequel "6G and Onward to Next G: The Road to the Multiverse" (Wiley-IEEE Press, February 2023).

Final Exam: Quiz on final day

Room and Schedule

Room: *Aula Riunioni del Dipartimento di Ingegneria dell'Informazione, Via G. Caruso 16, Pisa – Ground Floor*

Schedule:

1. 15/07/2024: 9:00-11:00 & 14:30-16:30
2. 16/07/2024: 9:00-11:00 & 14:30-16:30
3. 17/07/2024: 9:00-11:00 & 14:30-16:30
4. 18/07/2024: 9:00-11:00 & 14:30-16:30
5. 19/07/2024: 9:00-11:00 & 14:30-16:30