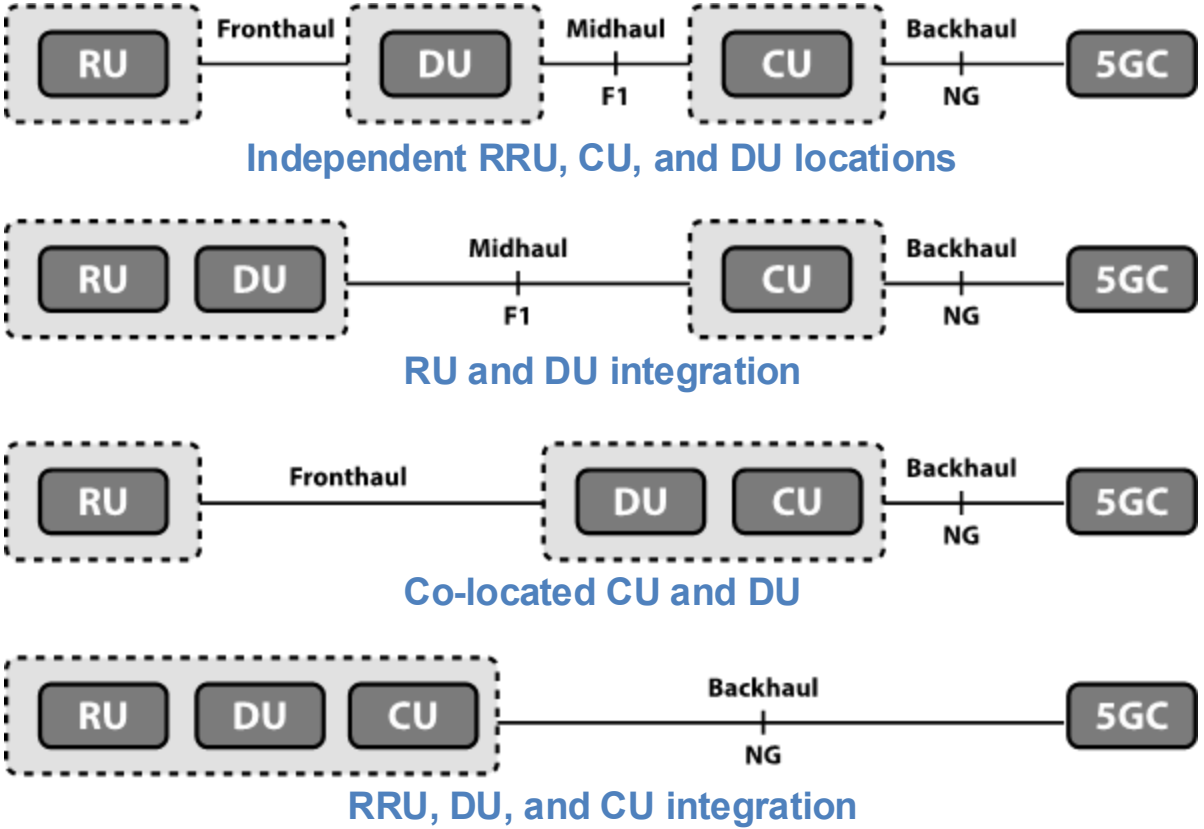
RAN Deployment Scenarios

Baseband refers to the original frequency range of a transmission signal before it is modulated

A **BaseBand Unit (BBU)** is a unit that processes baseband

A common arrangement is a BBU containing both CU and DU functionality, and one or more RUs, either collocated or remote (RRUs).



ITU-T Technical Report GSTR-TN5G (Transport Network Support of IMT-2020/5G

Challenges

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Need of intelligence to manage and orchestrate the complexity

Resource Orchestration

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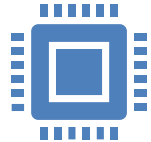
- Data resources



Computing

Storage

- Network resources

Interconnectivity

Access

- User mobility

Resource Orchestration

- Three requirements:
  - Security
  - Dependability
  - Performance

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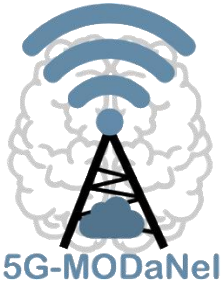
5G-MODaNeI Project

- **5G M**anagement and **O**rchestration For **Da**ta and **Ne**twork **I**ntegration



- Funded by the Norwegian Research Council

The Research Council of Norway

- 5-year project (3 PhD students and 1 postdoc)
- 2020-2025
- 2 international research partners

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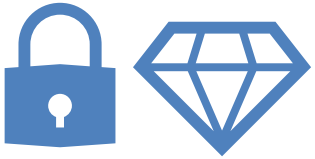
5G-MODaNeI in a Nutshell

- 5G Multi-access Edge Computing

- Security and dependability



- AI-based orchestration of resources

- Vehicular communication testbed

Outline

- Principles of Cellular Networks — *13.1 1.2*
- Evolution of Cellular Networks — *13.3, 13.5 1.1, 1.3, 1.4, 1.5*
  - Fourth Generation (4G) — *Ch.14 1.6*
  - Sixth Generation (6G) — *Rec. ITU-R M.2160*
- Fifth Generation (5G) — *Ch. 2, Ch. 3, Ch. 8, Ch. 15*

Related Research Material

- Software-defined 5G
  - **G. Nencioni, R. G. Garroppo, A. J. Gonzalez, B. E. Helvik, and G. Procissi; "Orchestration and Control in Software-Defined 5G Networks: Research Challenges"; Wireless Communications and Mobile Computing, 2018, DOI: 10.1155/2018/692386**
- Dependability in SDN
  - G. Nencioni, B. E. Helvik, and P. E. Heegaard; "Including Failure Correlation in Availability Modelling of a Software-Defined Backbone Network"; IEEE Transactions on Network and Service Management, Vol 14, Issue 4, December 2017, DOI: 10.1109/TNSM.2017.2755462
  - A. J. Gonzalez, G. Nencioni, B. E. Helvik, and A. Kamisinski; "A Fault-Tolerant and Consistent SDN Controller"; IEEE Global Telecommunications Conference (GLOBECOM 2016), Dec 4-8, 2016, Washington, DC, USA
- Dependability in NFV
  - **A. J. Gonzalez, G. Nencioni, A. Kamisinski, B. E. Helvik, and P E. Heegaard, "Dependability of the NFV Orchestrator: State of the Art and Research Challenges"; IEEE Communications Surveys and Tutorials, Vol. 20, Issue 4, pp. 3307-3329, Fourthquarter 2018, DOI: 10.1109/COMST.2018.2830648**
  - B. Tola, G. Nencioni, and B. E. Helvik; "Network-Aware Availability Modeling of an End-to-End NFV-enabled Service"; IEEE Transactions on Network and Service Management, Vol 16, Issue 4, December 2019, DOI: 10.1109/TNSM.2019.2948725
- Network slicing security and isolation
  - **R. F. Olimid and G. Nencioni; "5G Network Slicing: A Security Overview"; IEEE Access, Vol 8, Pages 99999–100009, 2020, DOI: 10.1109/ACCESS.2020.2997702**
  - **A. J. Gonzalez, J. Ordonez-Lucena, B. E. Helvik, G. Nencioni, M. Xie, D. R. Lopez, and P. Grønsund; "The Isolation Concept in the 5G Network Slicing"; European Conference on Networks and Communications (EuCNC), June 15-18, 2020, Dubrovnik, Croatia**

Related Research Material

- Security, Dependability, and Performance in 5G MEC
  - **G. Nencioni, R. G. Garroppo, and R. F. Olimid; "5G Multi-access Edge Computing: a Survey on Security, Dependability, and Performance"; IEEE Access, vol. 11, Pages 63496-63533, 2023, DOI:10.1109/ACCESS.2023.3288334**
- Dependability in 5G MEC
  - T. Pathirana and G. Nencioni; "Availability Model of a 5G-MEC System"; International Conference on Computer Communications and Networks (ICCCN), July 24-27, 2023
- Orchestration in 5G MEC (and network slicing)
  - **A. Sarah, G. Nencioni, and M.I I. Khan; "Resource Allocation in Multi-Access Edge Computing for 5G-and-Beyond Networks"; Elsevier Computer Networks, vol. 227, 109720, 2023, DOI: 10.1016/j.comnet.2023.109720**
  - M. I. Khan and G. Nencioni; "Revenue Maximization of a Slice Broker in the Presence of Byzantine Faults"; Workshop of the Annual IEEE/IFIP International Conference on Dependable Systems and Networks (DSN), June 27-30, 2023
  - F. Mason, G. Nencioni and A. Zanella; "Using Distributed Reinforcement Learning for Resource Orchestration in a Network Slicing Scenario"; IEEE/ACM Transactions on Networking, 2022, DOI: 10.1109/TNET.2022.3187310.
- 5G-MEC Testbed
  - **P. V. Wadatkar, R. G. Garroppo, and G. Nencioni; "5G-MEC Testbeds for V2X Applications"; Future Internet, vol. 15, no. 5: 175, 2023, DOI: 10.3390/fi15050175**
  - M. A. Hathibelagal, R. G. Garroppo, and G. Nencioni; "Experimental comparison of migration strategies for MEC-assisted 5G-V2X applications"; Elsevier Computer Communications, vol. 197, Pages 1-11, 2023, DOI: 10.1016/j.comcom.2022.10.009
  - P. V. Wadatkar, R. G. Garroppo, and G. Nencioni; "MigraMEC: Hybrid Testbed for MEC App Migration"; Annual International Conference On Mobile Computing And Networking (MobiCom), October 2-6, 2023