Validating 5G in vertical industries: the 5Growth project

5G-enabled Growth in Vertical Industries

October 2020

5G Trials in Europe - 5G Experimentation Facilities and Vertical Trials

Carlos J. Bernardos (UC3M, Project Coordinator)
Outline

- Project overview
- 5Growth architecture
- Vertical pilot use cases
Objectives
- The main objective is the technical and business validation of 5G technologies from the verticals' points of view, by performing field-trials on 4 vertical sites
- Leverage on the results of 5G-PPP Phase 2 projects, mainly 5G-TRANSFORMER
- Apply and enhance two ICT-17-2018 5G End-to-End platforms: 5G EVE and 5G-VINNI

Pilots and field trials
- 4 pilots across 4 vertical industries
- 9 use cases will be field-trialed on 4 vertical-owned sites (in Spain, Italy, Portugal) in close collaboration with the vendors (Ericsson, Interdigital, NEC, Nokia) and the operators (Telefonica, Telecom Italia and Altice Labs/PT)

Consortium (21 partners)
- Verticals: Innovalia, EFACEC Engineering/Systems, COMAU
- Operators: Telecom Italia, Telefonica, Altice Labs
- Vendors: NEC, ERICSSON Spain/Italy, NOKIA Bell Labs, IDCC
- SMEs: Nextworks, Mirantis, Telcaria
- Research Centers: CTTC
- Universities: POLITO, SSSA, UC3M, NKUA, ITAv

5Growth.eu
twitter.com/5growth_eu
linkedin.com/in/5growth-project
Vertical pilots

• 5Growth aims to perform real field trials involving customer sites of four vertical locations in Portugal, Spain & Italy

• This requires the development, installation, validation and testing of pre-commercial 5G radio, transport and core technology in vertical sites, connected via the ICT-17 platforms

• Pilots
  • Industry 4.0:
    • INNOVALIA
    • COMAU
  • Energy:
    • EFACEC_E
  • Transportation:
    • EFACEC_S
Interactions with ICT-17 projects

• ICT-17 platform (5G-EVE and 5G-VINNI) are key for us

• We use ICT-17 platforms for
  • First tests and validations of our vertical pilots
    • A gap analysis (what 5Growth needs vs what ICT-17 can provide) was performed at the beginning of the project
  • Designing, implementing and deploying the missing functions required for the vertical trials into ICT-17 platforms (and vertical sites)
    • This includes the 5Growth platform (which adds new innovations)
  • Integration with vertical systems and execution of the different vertical pilots
Outline

- Project overview
- **5Growth architecture**
- Vertical pilot use cases
Vertical Slicer (5Gr-VS)
- Acting as a single entry point for all verticals to request their custom network slice.
- Mapping vertical services onto network slices (realized through Network Services, NFV-NS).
- Managing vertical service and respective network slices.

Service Orchestrator (5Gr-SO)
- E2E Orchestration of NFV-NSs
  - Multi-domain service and resource orchestration.
  - Managing NFV-NSs
    - Life-cycle Management
    - SLA management

Resource Layer (5Gr-RL)
- Manage the physical/virtual transport, mobile/RAN, MEC and Cloud resources to deploy NFV-NS requested by 5Gr-SO.
- Provide a unified view of the underlying networks to 5Gr-SO with a suitable abstraction and configuration of heterogeneous resources via different plugins.

Vertical Services (VSB)
- VSB->VSD->NSD
- Vertical Service -> Network Slice
- Network Slice -> NFV Network Service

NFV Network Service (NSD and flavors)
- Request resource allocation and instantiation of NFV-NS on the underlying infra.

Manage various infra. Resources and execute actual mapping of a logical network (network slice) on the shared physical network.
Extending Baseline Architecture
The first release software (R1) of the 5Growth platform has been published as open source on public github in May 2020 ([https://github.com/5growth](https://github.com/5growth))

<table>
<thead>
<tr>
<th>Innovation</th>
<th>Repository</th>
<th>License</th>
</tr>
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<tbody>
<tr>
<td>RAN segments in network slices</td>
<td><a href="https://github.com/5growth/5gr-vs">https://github.com/5growth/5gr-vs</a></td>
<td>Apache v2.0</td>
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<td><a href="https://github.com/5growth/5gr-rl">https://github.com/5growth/5gr-rl</a></td>
<td>GPL</td>
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<td>Vertical-service monitoring</td>
<td><a href="https://github.com/5growth/5gr-mon">https://github.com/5growth/5gr-mon</a></td>
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<td>Control-loops stability</td>
<td><a href="https://github.com/5growth/5gr-so">https://github.com/5growth/5gr-so</a></td>
<td>Apache v2.0</td>
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<td>Smart orchestration and resource control algorithms</td>
<td><a href="https://github.com/5growth/5gr-rl/tree/master/5gr-rl-ra-server/">https://github.com/5growth/5gr-rl/tree/master/5gr-rl-ra-server/</a></td>
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<td><a href="https://github.com/5growth/5gr-rl/tree/master/rl/plugins/WIM/ONOS-P4-Slicing">https://github.com/5growth/5gr-rl/tree/master/rl/plugins/WIM/ONOS-P4-Slicing</a></td>
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- **Vertical pilot use cases**
### Vertical use cases

Field-trial-based approach on vertical sites (TRL 6-7). In total, 4 pilots across 4 verticals and 9 use cases:

| **Industry 4.0 (INNOVALIA1):** | Connected Worker Remote Operation of Quality Equipment |
| **Industry 4.0 (INNOVALIA2):** | Connected Worker Augmented Zero Defect Manufacturing (ZDM) Decision Support System (DSS) |
| **Industry 4.0 (COMAU1):** | Digital Twin Apps |
| **Industry 4.0 (COMAU2):** | Telemetry/Monitoring Apps |
| **Industry 4.0 (COMAU3):** | Digital tutorials and remote support |
| **Transportation (EFACEC_S1):** | Safety Critical Communications |
| **Transportation (EFACEC_S2):** | Non-safety Critical Communications |
| **Energy (EFACEC_E1):** | Advanced monitoring and maintenance support of secondary substation - Medium Voltage/Low Voltage (MV/LV) distribution substation |
| **Energy (EFACEC_E2):** | Advanced critical signal and data exchange across wide smart metering and measurement infrastructures |
### Technical KPIs

#### eMBB
- Availability/Reliability (A/R): 99,9999%
- Latency (LAT): <5ms
- Bandwidth (BW): 1 Gbps
- Connection Density (DEN): <1000 devices per km²
- Mobility (MOB): 3 km/h
- Wide-Area Coverage (COV): 5-8 km²

#### mMTC
- Availability/Reliability (A/R): 99,9999%
- Latency (LAT): <5ms
- Bandwidth (BW): 10-20 Gbps
- Connection Density (DEN): <1000 devices per km²
- Mobility (MOB): 3-50 km/h
- Wide-Area Coverage (COV): 5 km²

#### URLLC
- Availability/Reliability (A/R): 99,9999%
- Latency (LAT): <15ms
- Bandwidth (BW): 200 Mbps (total)
- Connection Density (DEN): <1000 devices per km²
- Mobility (MOB): 3-50 km/h
- Wide-Area Coverage (COV): 5 km²

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#### Table 1: KPI Comparison

<table>
<thead>
<tr>
<th></th>
<th>EFACEC_S1</th>
<th>EFACEC_S2</th>
<th>EFACEC_E1</th>
<th>EFACEC_E2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latency (LAT)</td>
<td>&lt;10ms</td>
<td>&lt;100ms</td>
<td>&lt;7ms for AR</td>
<td>&lt;7ms for AR</td>
</tr>
<tr>
<td>Bandwidth (BW)</td>
<td>&gt;1200 bit/s</td>
<td>Downlink user experience data rate: &gt; 100 Mbps</td>
<td>Downlink user experience data rate: &gt; 100 Mbps</td>
<td>&lt;1ms for synchronization reading time</td>
</tr>
<tr>
<td>Mobility (MOB)</td>
<td>Speed &lt; 160 km/h (expected to have 80 km/h) in pilot scenario</td>
<td>Speed &lt; 120 km/h in pilot scenario</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wide-Area Coverage (COV)</td>
<td>2-30 km²</td>
<td>2-30 km²</td>
<td>10 km²</td>
<td>10 km²</td>
</tr>
</tbody>
</table>
Motivation for this Pilot

1. Every time the measuring machine is reconfigured (for example changes in the piece design), an expert metrologist has to go there and help defining the measuring trajectories for the optical sweep.

2. High volume of data transmitted in real time needs a reliable, high-capacity connection, that nowadays is only available by a wired network. This limits the mobility of operators and may require expensive infrastructures.

Example: Industry 4.0 Pilot

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Example of Industry 4.0 UC1: Connected Worker Remote Operation of Quality Equipment (INNOVALIA Pilot)

- Remote real-time operation via a virtual joystick by worker for remote control and programming of CMM
- 5G requirements: high data rate, reliability and low latency
- Potential benefits: Remote expert manpower and time/travel savings

**Stakeholders**

- **Vertical**: INNOVALIA
- **Operator**: Telefonica
- **HW/SW provider**: Ericsson
- **Video streaming service provider**: InterDigital
- **Operation Support Provider**: TELCA

**eMBB slice (4k video)**

- 10Mbps req

**URLLC slice (control)**

- Reliability: 99.99%
- E2E Latency <5ms

Coordinate Measuring Machine (CMM)
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 856709.