The 5G EVE End-to-End Facility Webinar for Vertical Industries involved in 5G EU Projects

Technical Overview

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Twitter hashtag: # 5GEveWebinar
Website: www.5g-eve.eu

Manuel Lorenzo (ERI-ES)
5G EVE Technical Overview

Outline

• Vision
• Services and Architecture
• Roadmap
• References
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The vision of 5G EVE’s E2E Validation Platform

From: Two Worlds

To: One Innovation Ecosystem

5G-enabled Industry Applications
- Agile
- Diverse
- Specialized
- Transformative

European 5G Validation Platforms
- Open
- Ease-to-use
- Trustworthy
- Automated

5G Technologies
- Performing
- Scalable
- Standard
- Secure
- Evolving

This Project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 815074
How 5G EVE architects that vision
What 5G EVE offers to Vertical experimenters

Smooth Execution and Testing of your 5G ready applications over a State-of-the-art 5G Technology Platform

Increased effectiveness, efficiency and confidence of your 5G Validation activities

This Project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 835074
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5G EVE Platform – Driving Requirements

5G EVE platform services are designed considering the following requirements:

- Open framework APIs that facilitate verticals, easy and fast access to 5G services.
- APIs to isolate verticals Service Requests (what) from specific network capabilities (how).
- Platform services with sites interworking capabilities.
- Single Platform-services access to all verticals.
5G EVE Platform - Validation Test as a Service

Process Workflow

Collaboration Agreement?
Test Executable?
Test Prepared?
Test Executed?
Test Results?

Time

1 Month
Test Design
- Test definition: goals, conditions, assumptions and expected results
- Test feasibility Analysis
- Test Specification

1-2 Month
Test Preparation
- Vertical Equipment integration in Platform
- Test Definition
- Test development
- Testing environment preparation
- Test Planning Handshake

2-4 Week
Test Execution and Monitoring
- Test Execution and Performance Monitoring
- Test Logs and Output data collection

2-4 Week
Test Analysis
- Test analysis and performance evaluation
- Test performance troubleshooting

Activities

Outcome

Test Specification
Test Plan
Test Execution Report
Final Report

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5G EVE Platform - Validation Test as a Service

- The experimenter will gain insight on performance based on the collection and analysis of all relevant data and results of the experiment.

- The experimenter may monitor the progress of the experiment, online, via a GUI. Multiple real-time statistics will be displayed.

- The experimenter will have the ability to seamlessly browse through extensive lists of the available 5G EVE features, components and services.

- Open interface between the 5G EVE and the vertical for defining and deploying their experiments, based on the novel concept of intent-based networking.

- The experimenter will be able to seamlessly browse through extensive lists of the available 5G EVE features, components and services.

- The experimenter will have the ability to browse and look-up of available services in the Platform.

- The experimenter will have the ability to browse through extensive lists of the available 5G EVE features, components and services.

- The experimenter will have the ability to monitor and maintain the experiment.
5G EVE Architecture – Verticals’ View

Vertical End-User Service is delivered at one or more sites.

Vertical Tester/Experimenter interacts with 5G EVE platform through 5G EVE Portal.
### 5G EVE Architecture – Implementation View

<table>
<thead>
<tr>
<th>5G EVE Portal (WEB)</th>
<th>5G EVE Interworking Framework</th>
<th>Management &amp; Orchestration</th>
<th>Control</th>
<th>Data</th>
<th>Physical Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment Design Tool</td>
<td>Multi-site Network Service Orchestrator</td>
<td>Domain-Specific Management Tools</td>
<td>Control Plane VNFs</td>
<td>Data Plane VNFs</td>
<td>Radios</td>
</tr>
<tr>
<td>Run Experiment Tool</td>
<td>Multi-site Catalogue</td>
<td>Slice Manager</td>
<td>Control Plane PNFs</td>
<td>Data Plane PNFs</td>
<td>Transmission Links FH/BH</td>
</tr>
<tr>
<td>Advanced 5G Testing Tool</td>
<td>Multi-site Inventory</td>
<td>VNFM</td>
<td>SDN Controllers</td>
<td>Edge Managers</td>
<td>Routers &amp; Switches</td>
</tr>
<tr>
<td></td>
<td>Data Collection Manager</td>
<td>OSS / BSS</td>
<td>Edge &amp; Network Clouds</td>
<td>Edge &amp; Network Clouds</td>
<td>Edge &amp; Network Clouds</td>
</tr>
<tr>
<td></td>
<td>Runtime Configurator</td>
<td></td>
<td></td>
<td></td>
<td>PNF HW</td>
</tr>
<tr>
<td></td>
<td>Data Collection Manager</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>KPI Analytics &amp; Performance Diagnosis Tool</td>
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<td></td>
</tr>
</tbody>
</table>

#### Common 5G EVE functional blocks
Common to all sites; secure homogeneous platform services to Verticals

#### 5G EVE Site functional blocks
Based on different technologies and implementations for different sites; enable richer tests
5G EVE Architecture - Technologies & Standards

- Flexible Numerology
- Massive MIMO
- Multi-User MIMO
- RAN Virtualization
- Latency Reduction

• Low Bands (800 MHz)
• Mid Bands (2.6 GHz, 3.4-3.8 GHz)
• High Bands (optional)

- eMBB
- URLLC
- mMTC

- NFVi
- SDN
- Vertical App Deployment

- vEPC supporting 5G
- CUPS
- 5G
- SBA
- Interworking with LTE

- Network Slicing
- Service Slicing
- Multi-X Slicing

- Legacy
- Rel15-5G NR + EPC in NSA mode
- Rel15-5G NR + Rel15-5G Core in SA mode
- Rel16-5G NR + Rel16-5G Core (NSA & SA)

- 3GPP Edge Computing
- ETSI MEC
5G EVE Architecture - Key 5G EVE innovations

1. Intent-based interface towards verticals
   A disruptive intent-based interface to simplify the access to the 5G end to end facility, specifying "what" is asked without details on "how" it is provided.

2. Multi-domain slicing and orchestration
   A new orchestration framework with the necessary features able to manage effectively multiple site facilities, dramatically improve efficiency, prevent overload, and easily manage migration of networks components, while meeting performance requirements.

3. Performance Diagnostics (KPI Framework)
   A completely new performance diagnosis mechanism and a new monitoring framework enabling the capturing of service and slice performance indicators, providing insight on performance.

4. 5G VNF’s (Openness Framework)
   A new framework to provide a modular, reusable set of different SFs enabling the coexistence of proprietary and open source technologies; this will allow the modular replacement and chaining of components implemented with open and novel performance acceleration techniques.
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5G EVE Roadmap – General Time-line

- **Project Start**: Jul 2018
- **Platform Drop0**: May 2019
- **Platform Released**: Jan 2020
- **Platform Upgraded**: Jul 2020
- **Platform Upgraded**: Jan 2021
- **Project End**: Jun 2021

1. **1st Round of Tests**
2. **2nd Round of Tests**
3. **3rd Round of Tests**
4. **4th Round of Tests**

**ICT-17**
- Spec. & Planning

**ICT-19**
- Spec. & Planning

**ICT&SMEs**
- Spec. & Planning

**Deployment, Execution and Analysis of Trials**

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5G EVE Roadmap - Highlights

5G EVE’s 5G Capabilities
- LTE+vEPC
- Pre-Scheduling
- NFVI + CUPS
- LTE-M+NB-IoT+MBB
- R15 5GNR+EPC (NSA)
- Massive MIMO
- Network Slicing + EC
- eMBB
- R15 5GNR+5GC (NSA)
- Multi-User MIMO
- Service Slicing + SBA
- URLLC (R15)
- R16 5GNR+5GC (SA)
- RAN Virtualization
- Multi-X Slicing
- URLLC+mMTC (R16)
- RAN Virtualization
- Multi-X Slicing
- URLLC+mMTC (R16)

5G EVE’s Added-Value Features
- Initial Testing Toolbox
- KPI User Data Rate
- Limited Testing Portal
- KPI RTT Latency+Rel.
- Interconnected Sites
- Control Plane I/W
- Full Testing Portal
- KPI Peak Data Rate
- Interconnected ICT17
- Multi-Site E2E I/W
- Advanced Diagnostics
- KPI Capacity+Availab.
- Interconnected ICT19
- Data Plane I/W

5G EVE Platform’s 5G Capabilities fully deployed and consolidated

May 2019
- LTE+vEPC
- Pre-Scheduling
- NFVI + CUPS
- LTE-M+NB-IoT+MBB

Jan 2020
- R15 5GNR+EPC (NSA)
- Massive MIMO
- Network Slicing + EC
- eMBB
- R15 5GNR+5GC (NSA)
- Multi-User MIMO
- Service Slicing + SBA
- URLLC (R15)

Jun 2021
- R16 5GNR+5GC (SA)
- RAN Virtualization
- Multi-X Slicing
- URLLC+mMTC (R16)
- RAN Virtualization
- Multi-X Slicing
- URLLC+mMTC (R16)

Full-fledged 5G EVE Framework

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# 5G EVE 5G Capabilities Roadmap (1 of 2)

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Features</th>
<th>2019/MAY</th>
<th>2020/JAN</th>
<th>2020/JUL</th>
<th>2021/JAN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Allocated Spectrum</strong></td>
<td>Low Bands (800 MHz)</td>
<td>Y (10MHz)</td>
<td>Y (10MHz)</td>
<td>Y (10MHz)</td>
<td>Y (10MHz)</td>
</tr>
<tr>
<td></td>
<td>Mid Bands (2.6 GHz, 3.4-3.8 GHz)</td>
<td>Y (20MHz)</td>
<td>Y (40MHz)</td>
<td>Y (40MHz)</td>
<td>Y (100MHz)</td>
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<tr>
<td></td>
<td>High Bands (26 GHz)</td>
<td>(optional)</td>
<td>(optional)</td>
<td>(optional)</td>
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</tr>
<tr>
<td><strong>5G Services</strong></td>
<td>Enhanced MBB (eMBB)</td>
<td>Y</td>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>URLLC (URLLC)</td>
<td>(Pre-sched)</td>
<td>Y(Rel-15)</td>
<td>Y(Rel15)</td>
<td>Y(Rel-16)</td>
</tr>
<tr>
<td></td>
<td>Massive IoT (mMTC)</td>
<td>Y (LTE-M+NB-IoT)</td>
<td>Y (LTE-M+NB-IoT)</td>
<td>Y (LTE-M+NB-IoT)</td>
<td>Y(Rel-16)</td>
</tr>
<tr>
<td><strong>5G Architecture Options</strong></td>
<td>Option-1 (Legacy)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Rel15-5GNR + EPC in NSA mode</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Rel15-5GNR + Rel15-5GC in SA mode</td>
<td>Y</td>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Rel16-5GNR + Rel16-5GCore (in NSA &amp; SA modes)</td>
<td>Y</td>
<td></td>
<td></td>
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<tr>
<td><strong>5G Access Features</strong></td>
<td>Flexible Numerology</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Massive MIMO</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Multi-User MIMO</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>RAN Virtualization</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Latency Reduction (pre-scheduling)</td>
<td>Y (Rel-15)</td>
<td>Y(Rel15)</td>
<td>Y(Rel15)</td>
<td>Y(Rel-16)</td>
</tr>
<tr>
<td></td>
<td>Optional(Multi-RAT, Spectrum Aggregation, New)</td>
<td>optional</td>
<td>optional</td>
<td>optional</td>
<td>optional</td>
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</table>
## 5G EVE 5G Capabilities Roadmap (2 of 2)

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Features</th>
<th>2019/MAY</th>
<th>2020/JAN</th>
<th>2020/JUL</th>
<th>2021/JAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Network</td>
<td>vEPC supporting 5G</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>5GC</td>
<td></td>
<td></td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>CUPS</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td></td>
<td>SBA</td>
<td></td>
<td></td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Interworking with LTE</td>
<td></td>
<td></td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Slicing</td>
<td>Network Slicing (std 5G Services: eMBB, URLLC, mMTC)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Service Slicing (cloud orchestration level)</td>
<td>Y</td>
<td></td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Multi-site Slicing</td>
<td></td>
<td></td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Virtualization</td>
<td>NFVi support</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>SDN control</td>
<td></td>
<td></td>
<td>TBD</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Vertical Virtualized Application deployment support</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Edge Computing</td>
<td>3GPP Virtualized Application deployment support</td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ETSI MEC</td>
<td></td>
<td></td>
<td>(optional)</td>
<td>(optional)</td>
</tr>
<tr>
<td></td>
<td>Interconnection among 5G EVE Sites</td>
<td>Y (*)</td>
<td></td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Interconnection with other ICT17 platforms</td>
<td></td>
<td></td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td></td>
<td>Interconnection with other ICT19 projects' infra</td>
<td></td>
<td></td>
<td>TBD</td>
<td>TBD</td>
</tr>
</tbody>
</table>
# 5G EVE KPI Roadmap

<table>
<thead>
<tr>
<th>5G-EVE KPIs (D1.1)</th>
<th>ITU-R M.2410-0 (11/2017)</th>
<th>2019/MAY</th>
<th>2020/JAN</th>
<th>2020/JUL</th>
<th>2021/JAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Data Rate</td>
<td>DL User Experienced Data Rate (Mbps): 100 Mbps</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>UL User Experienced Data Rate (Mbps):  50 Mbps</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Peak Data Rate</td>
<td>DL Peak Data Rate (Gbps): 20 Gbps</td>
<td></td>
<td></td>
<td>Y (mmW)</td>
<td>Y (mmW)</td>
</tr>
<tr>
<td></td>
<td>UL Peak Data Rate (Gbps): 10 Gbps</td>
<td></td>
<td></td>
<td>Y (mmW)</td>
<td>Y (mmW)</td>
</tr>
<tr>
<td>Capacity</td>
<td>Area Traffic Capacity (Mbit/s/m²): 10 Mbit/s/m²</td>
<td></td>
<td></td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Latency</td>
<td>UP Latency (ms): 1ms (URLLC), 4 ms (eMBB)</td>
<td>Y(LTE)</td>
<td>Y(4 ms)</td>
<td>Y(4 ms)</td>
<td>Y(1ms)</td>
</tr>
<tr>
<td></td>
<td>CP Latency (ms): &lt;20 ms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device Density</td>
<td>Connection Density: 1 M devices/km² (mMTC)</td>
<td></td>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>Mobility</td>
<td>Stationary: 0 km/h</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Pedestrian: 0 km/h to 10 km/h</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Vehicular: 10 km/h to 120 km/h</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Reliability</td>
<td>Reliability (%)</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Availability</td>
<td>Availability (%)</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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</tbody>
</table>
## 5G EVE Testing Framework Roadmap

<table>
<thead>
<tr>
<th>Key Features</th>
<th>Brief Description</th>
<th>2019/MAY</th>
<th>2020/JAN</th>
<th>2020/JUL</th>
<th>2021/JAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing/Validation toolbox</td>
<td>Initial set of standalone testing/validation tools meant to be used by the site owners</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Limited Testing Portal</td>
<td>The 1st version of the Portal available with limited functionalities:</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>• Blueprints for ASTI and Trenitalia,</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>• Deploy a network service in a single trial site</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>• Capacity to show some metrics</td>
<td></td>
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<tr>
<td></td>
<td>• Capacity to show information about the VNFs and PNFs available in a single site.</td>
<td></td>
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</tr>
<tr>
<td>Full-fledged Testing Portal</td>
<td>• browse and look-up tool</td>
<td></td>
<td></td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>• intent-based</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>• monitoring and result data collection</td>
<td></td>
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<td></td>
<td>• trouble-ticketing system</td>
<td></td>
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<tr>
<td></td>
<td>• Execution of the experiments</td>
<td></td>
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<td></td>
<td>• Scheduling of experiments</td>
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<td></td>
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<tr>
<td></td>
<td>• Testing/validation methodology integrated</td>
<td></td>
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<tr>
<td>KPI Support</td>
<td>• Basic Initial KPI Support (data rate and E2E latency)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Advanced KPI Support</td>
<td></td>
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<tr>
<td>Performance Diagnosis Capabilities</td>
<td>Basic Performance Diagnosis Capabilities</td>
<td></td>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>• Available to the verticals</td>
<td></td>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>• Related to the identifications of problems</td>
<td></td>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Advanced Performance Diagnosis Capabilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Available to the verticals</td>
<td></td>
<td></td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>• Identification of problems and proposition of solutions</td>
<td></td>
<td></td>
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</tbody>
</table>
# 5G EVE Interworking Framework Roadmap

## Key Features

<table>
<thead>
<tr>
<th>Features for single-site scenarios</th>
<th>Brief Description</th>
<th>2019/MAY</th>
<th>2020/JAN</th>
<th>2020/JUL</th>
<th>2021/JAN</th>
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<tr>
<td>WP2 feature: Local Resources</td>
<td>Site implication to support Verticals and Experiments</td>
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<tr>
<td>Control Plane Interworking</td>
<td>Control Plane constructed using best effort VPNs over Internet</td>
<td>Y</td>
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<tr>
<td>Single-Site Experiment Monitoring Support</td>
<td>Centralized capability to define and access Network and Service KPIs at specific sites</td>
<td>Y</td>
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<tr>
<td>Single-Site Applications Deployment Support</td>
<td>Centralized capability to define and access Network and Service KPIs at any site</td>
<td>Y</td>
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<tr>
<td>Single-Site Network Automation Support</td>
<td>Centralized capability to extract (Catalogue) and deploy VNFs automatically at specific sites</td>
<td>Y</td>
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<td>Centralized capability to extract (Catalogue) and deploy VNFs automatically at any site</td>
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<td>Additional features for multi-site scenarios</td>
<td>Centralized capability to automatically set up SDN-based Connectivity Services at specific sites</td>
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<tr>
<td>Multi-Site Experiment Monitoring Support</td>
<td>Centralized capability to automatically set up SDN-based Connectivity Services and Slices at any site</td>
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<td>Multi-Site E2E Orchestration Support</td>
<td>Centralized capability to automatically deploy multi-site Slices, and Applications running on top of them</td>
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<td>Data Plane Interworking</td>
<td>Data Plane constructed using best effort VPNs over Internet</td>
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<td>Data Plane constructed on top of a multi-gigabit low latency network</td>
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</table>
5G EVE Technical Overview
Outline

• Vision
• Services and Architecture
• Roadmap
• References
Useful information

General information on methodologies and solutions
→ https://www.5g-eve.eu/

Information on available facilities in the different sites
→ https://www.5g-eve.eu/end-to-end-facility
→ https://www.5g-eve.eu/videos/

Specific requests
→ https://www.5g-eve.eu/contact/
Thank you!