Summary of Deliverable 5.3:

Description of the spectrum needs and usage principles

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Contributors

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Outline

› Summary
› Spectrum usage in 5G
› Spectrum Usage Technology Components evaluation
› Spectrum Demand for 5G
› Spectrum band assessments
› Impact on mobile ecosystem of new spectrum usage
› Conclusions
Summary

› As in previous mobile generations, 5G is not only about new architecture and innovations in communications layers, but about new spectrum

› Furthermore due to the huge amount of spectrum needed to fulfill 5G requirements, new spectrum access will be needed.

› Mobile ecosystem business and the role of different actors will be impacted by the availability of new spectrum
Spectrum usage in 5G

 › Shared use of spectrum will be needed, in addition to licensed spectrum, to fulfil spectrum needs. Several approach could coexist
Spectrum usage in 5G. Technical enablers needed for spectrum sharing

› Several combinations of enablers could address the proposed spectrum sharing scenarios
› The number and combination of enablers would depend on spectrum needs and regulatory framework
Spectrum usage in 5G. Adapting spectrum usage to scenarios needs (MMC)

Different links needs lead to different enablers

- Primary user mode
  - Dedicated exclusive license
  - No sharing
  - Dedicated licensed spectrum
  - Bands < 6 GHz

- LSA mode
  - Dedicated LSA license
  - Sharing
  - Vertical sharing (as 2nd.ary user)
  - GLDB support

- Unlicensed mode
  - Primary users to be protected
  - No primary users
  - Unlicensed horizontal sharing
  - Bands < 6 GHz
  - Horizontal spectrum manager
  - Detection & DFS/DCS
  - WiFi sharing mode

Frequency Specific Enablers
Spectrum Sharing Toolbox
Frequency agile and sharing/coexistence friendly air interface design

Enabler domain

Regulatory framework
Spectrum usage scenarios
Spectrum usage in 5G. Functional architecture for spectrum usage

› Different links needs lead to different enablers
Spectrum Usage Technology Components evaluation

› Spectrum usage of Technology Components can be evaluated as enhancement in different KPIs

1) Increase of available spectrum per operator
2) Increase of network capacity per operator
3) Increase of average user throughput
4) Latency reduction
5) Overall system CAPEX reduction
6) Overall system OPEX reduction
7) Mobility support
8) Increase of edge user spectral efficiency
9) Relative spectrum occupation rate
10) Increase area spectral efficiency
Spectrum Demand for 5G. High demanding Test Cases

More than 1GHz and up to 3GHz BW required

Virtual reality office

Dense urban information society

Traffic jam

Open air festival

Real-time remote computing for mobile terminals
Spectrum Demand for 5G. Medium demanding Test Cases

› More than 200 MHz and up to 1GHz BW required

Shopping mall

Stadium
Spectrum Demand for 5G. Low demanding Test Cases

› Less than 100 MHz BW required

Emergency communications

Massive deployment of sensors and actuators

Traffic efficiency and safety
Spectrum band assessments. Below 40 GHz
Spectrum band assessments. From 40 to 100 GHz

[Diagram showing frequency bands from 40 to 100 GHz with different priority levels indicated]
Impact on mobile ecosystem of new spectrum usage. Involved actors

› New flexible spectrum management schemes are expected to make additional spectrum resources available, lowering the spectrum cost access barrier

› Future actors impacted by this flexibility are:
  - Mobile Network Operators (MNOs): Provision the mobile telecommunication services to end-subscribers
  - Mobile Virtual Network Operators (MVNOs), MNOs without own licensed spectrum resources
  - Internet service providers (ISPS): Provision the required internet access through different connection means
  - Local Network Operator (LNOs): Provision of mobile broadband services within local indoor locations
  - Equipment vendors
  - Facility owners (FOs)
Impact on mobile ecosystem of new spectrum usage. Expected actors investment strategies

<table>
<thead>
<tr>
<th>Spectrum Options</th>
<th>MNO &amp; MVNO as LNO</th>
<th>FO as LNO</th>
<th>Network Vendors and the Solution Providers as LNO</th>
<th>WISP as LNO</th>
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<tr>
<td>Dedicated Licensed Band</td>
<td>Backhauling could be an issue.</td>
<td>Dependency on MNO or WISP.</td>
<td>Authoritative Outsource or MSP (take care of network deployment and O&amp;M activities on behalf of MNO )</td>
<td>Owning the backhauling solution.</td>
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<td>Indoor deployment need agreement with FOs.</td>
<td>Competitive advantage: Facility,</td>
<td>New Business Model.</td>
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<td>Existing outdoor infrastructure.</td>
<td>More willingness to invest in local license</td>
<td>Competitive advantage: expertise,</td>
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<td>Tend to outsource, network deployment and O&amp;M activities</td>
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<td>Network Deployment cost.</td>
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<td>Licensed Shared Access (LSA)</td>
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<td>Upgrade cost</td>
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<td>More scalable network deployment to meet the capacity demand.</td>
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<td>Secondary access</td>
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<td>Unlicensed Bands In IM-Bands</td>
<td>Less willingness to invest in indoor infrastructure, O&amp;M overhead</td>
<td>End-users Handheld availability</td>
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<td>Interoperability with outdoor network</td>
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<td>immature Regulation Framework</td>
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Common Problems
- End-users Handheld availability
- Interoperability with outdoor network
- Immature Regulation Framework

Emerging business opportunity
- Based on Mutual roaming agreement and Partnership

More flexible business model
- Less dependencies on other actors

Strengths & Opportunities
- Flexible deployment (less need for experts)
- Competition (reduce market entry barriers)
- Spectrum Cost
- Better QoS and security aspects

Weakness & Threats
- Low
- High
Conclusion

› 5G scenarios, as they have been envisioned and characterized in METIS, require a significant increase on available spectrum.

› In order to make this new spectrum available, innovations in the spectrum access rights will be needed.

› New technology components and Spectrum usage architecture have been provided matching the foreseen needs of the new spectrum access scenarios.

› Frequency bands assessments for the provision of required BW has been carried out.

› New spectrum usage will impact different players among the mobile connectivity providers.