From IMT-2020 to Network-2030

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Content

1. Super high dense networks.
2. D2D Network.
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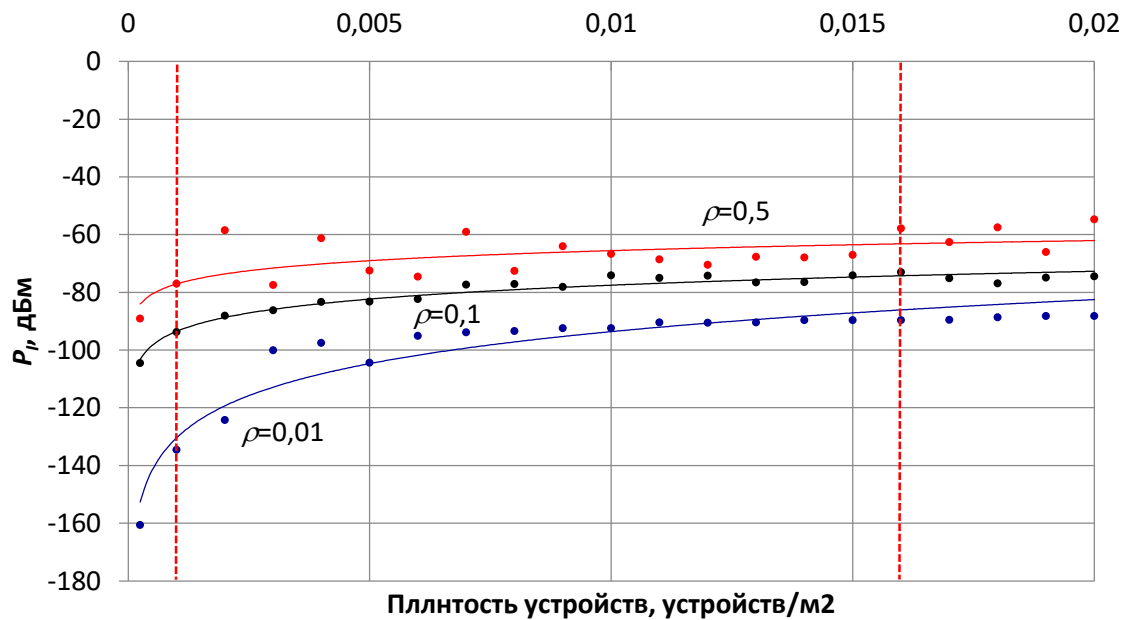6. Avatar communication.
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Specific features of IMT-2020 Networks

Super High Dense

Ultra low Latency

Super High Dense Networks

- Up to 1 mln devices per 1 square km
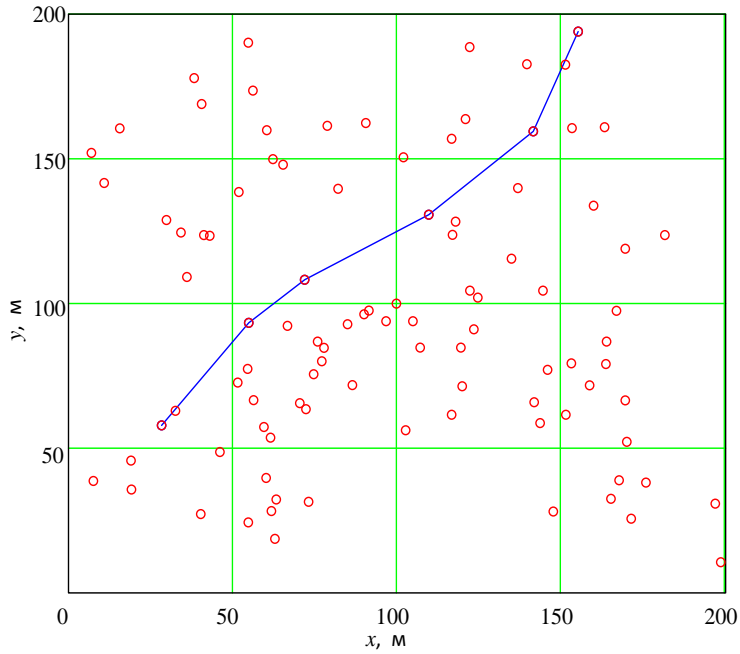- D2D communications
- WiFi Direct

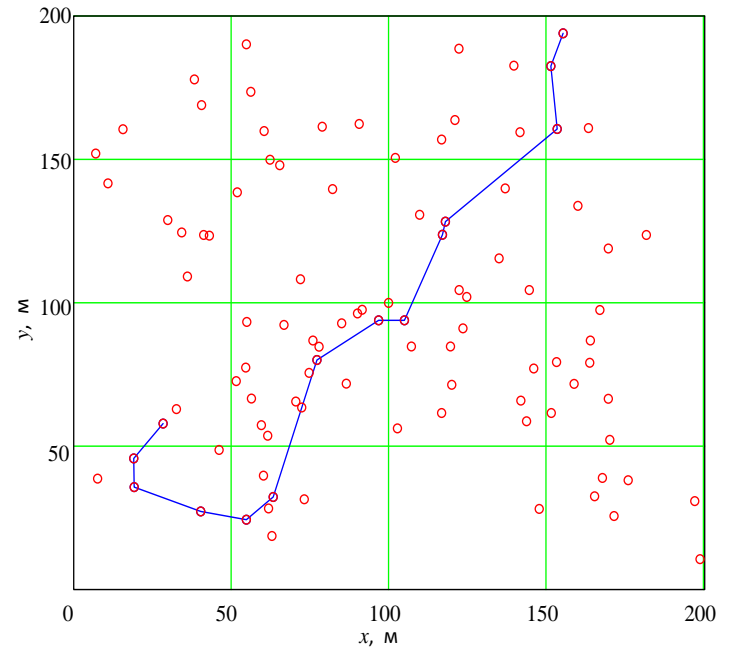# Super High Dense Networks (2)

Super High Dense Networks (3)

$$P_I = \frac{3,8}{\rho^{0,3}} \lg(d) - 6,8\lg(\rho) - 53,1$$

Super High Dense Networks (4)

The minimum path

The bandwidth maximum

D2D Network

- The D2D communications in the super high dense conditions establish a D2D network.
- In determining the interference, traffic that is generated in super dense networks in the route sections must be taken into account.
- The route of the shortest length can no longer be considered optimal.
- The development of new protocols for super dense networks using technologies D2D is required.

Ultra Low Latency

$$T = R×τ + Θ,$$

- R – distance,
- τ – latency due to light speed limitation (5 microsecond per km, Y.1541),
- Θ – latency due to network processing.
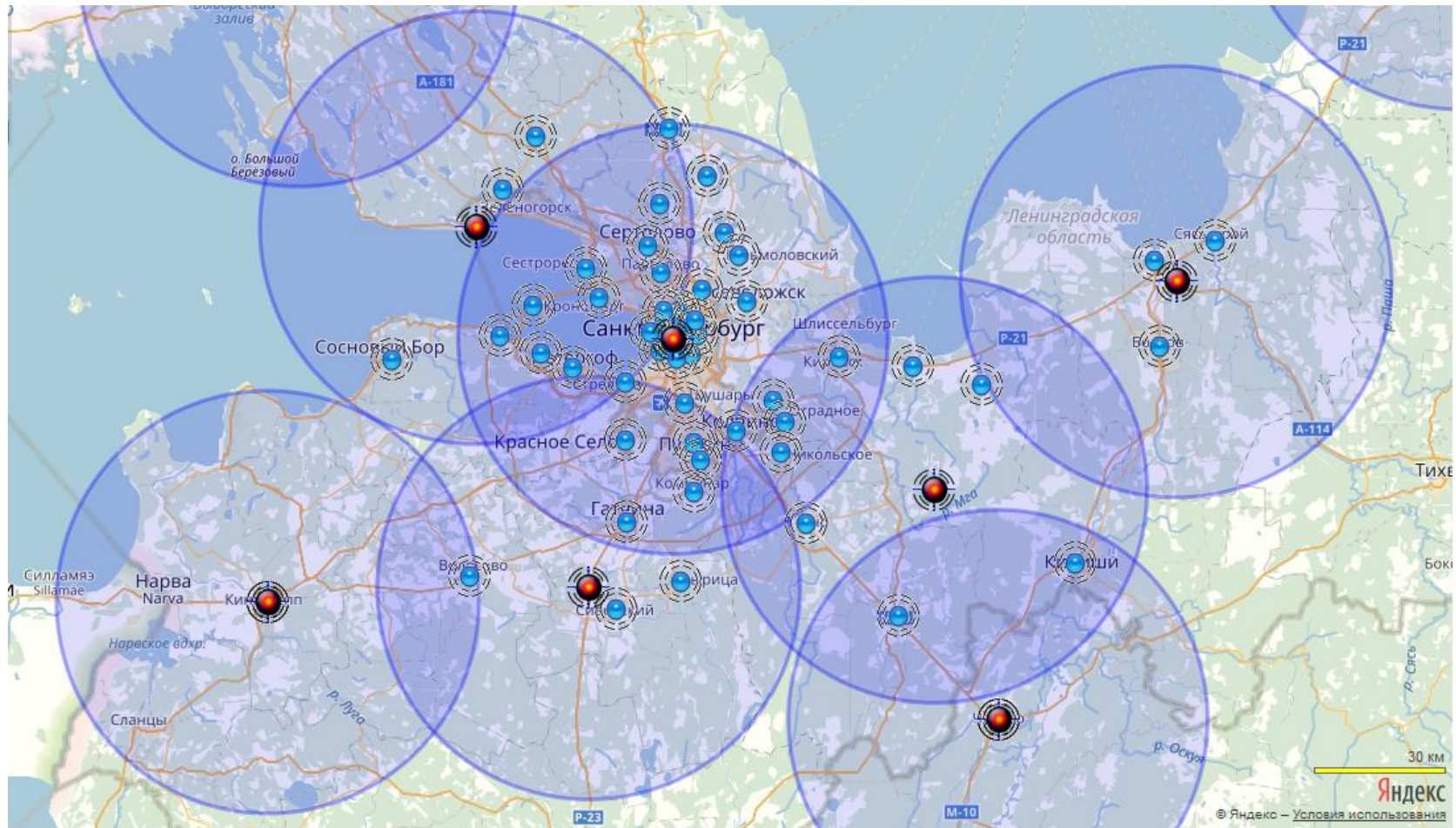
Ultra Low Latency (2)
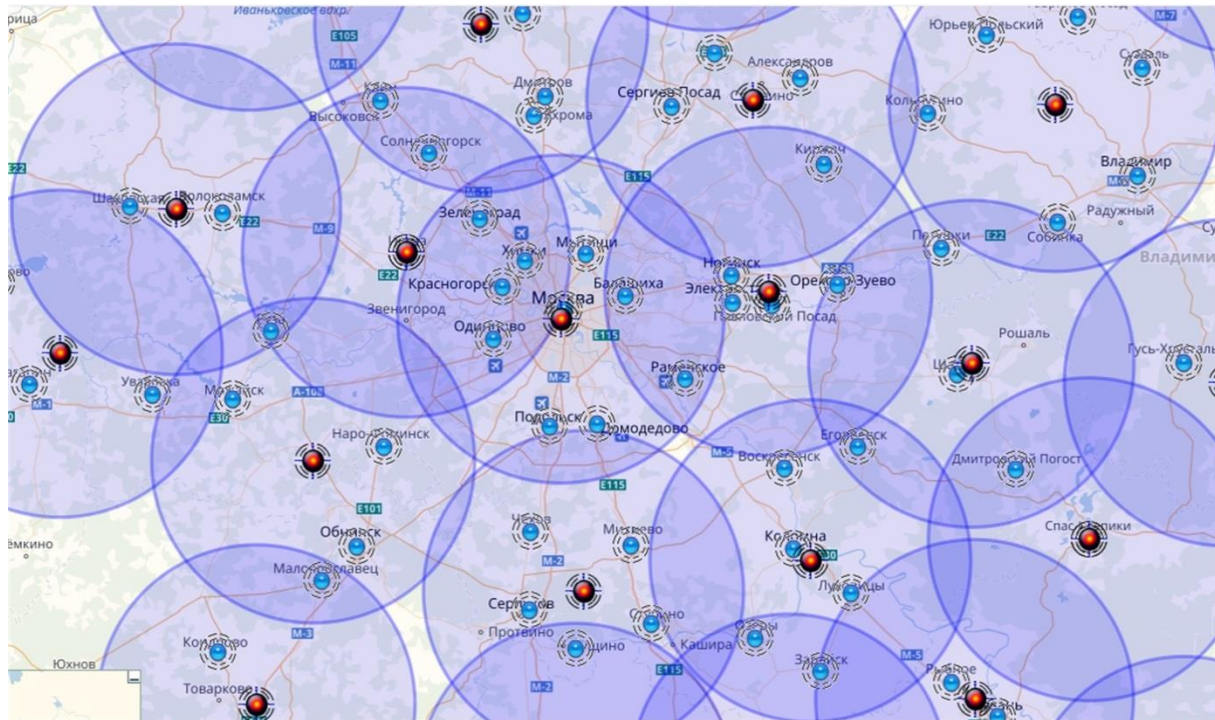
Round Trip Latency, R=50km

Satellite communication - ?

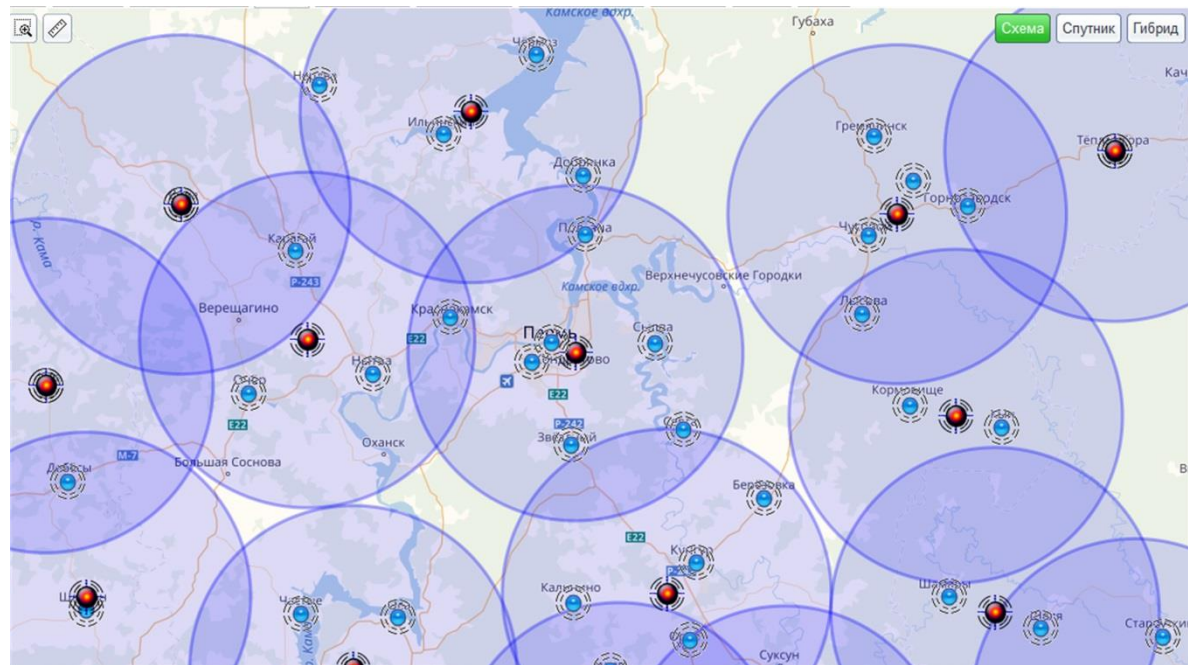Tethered platforms or tethered UAV's

The network clustering is needed.

Clustering (Leningrad region)

Clustering (Moscow region)

Clustering (Perm region)

Network with ultra low latency

- The network will be decentralized together with implementation of technologies with ultra low latency
- This will be the basis for the subsequent implementation of the Network-2030

Network-2030 vision

Беспилотный автотранспорт

Тактильный Интернет
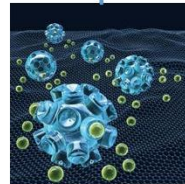
Дополненная реальность

Медицинские сети

Сеть связи с ультра малыми задержками 2030

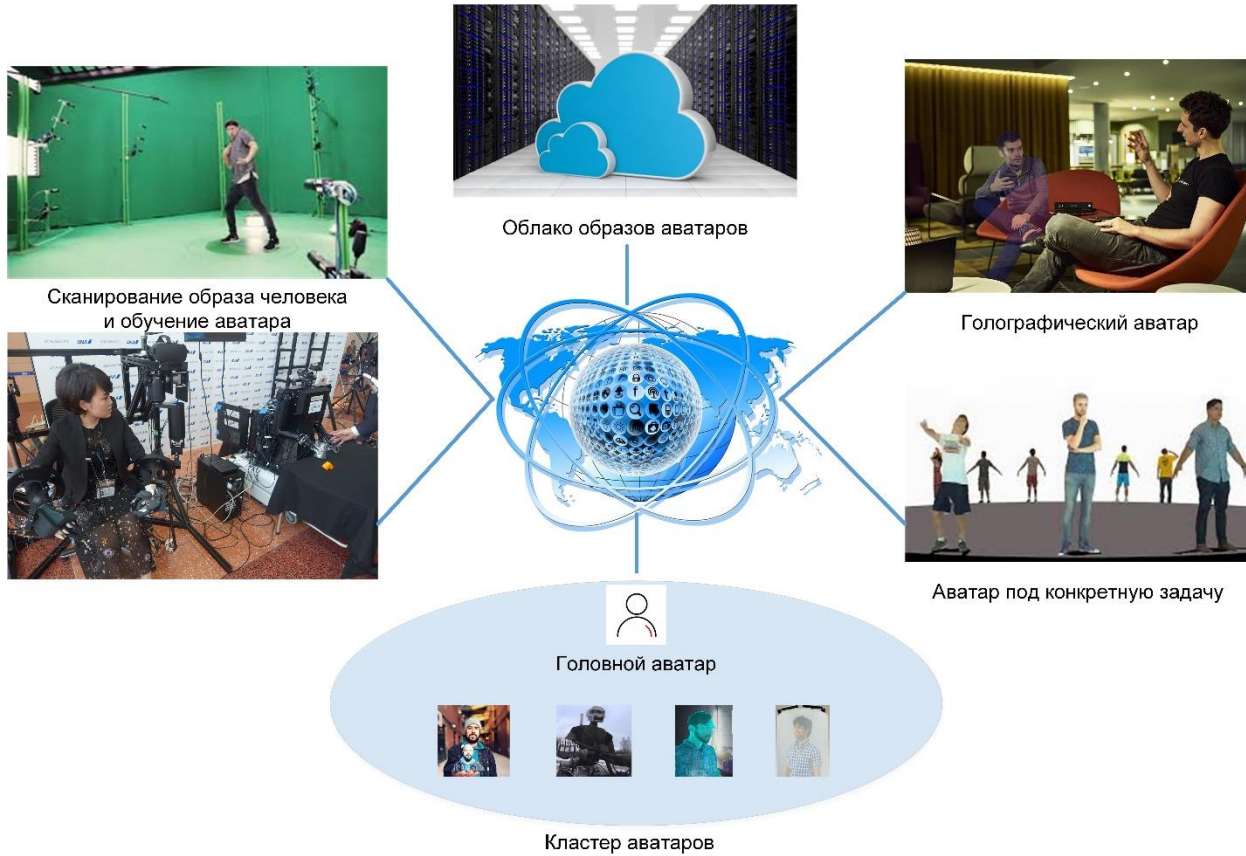Летающие сети

Промышленные гуманоиды

Наносети

Индустрия 4.0

Robots avatars

Сканирование образа человека
и обучение аватара

Облако образов аватаров

Голографический аватар

Аватар под конкретную задачу

Головной аватар

Кластер аватаров

Avatar communications

Human-to-Avatar (H2A)

Avatar-to-Human (A2H)

Avatar-to-Avatar (A2A).

Nano networks

```
            ┌─────────────────────────┐
            │          WNSN           │
            └─────────────────────────┘
              │                     │
    ┌──────────────────┐   ┌──────────────────────┐
    │    Molecular     │   │    Electromagnetic   │
    └──────────────────┘   └──────────────────────┘
```

Molecular nano networks

The human body,

food   (nm – mcm)

Average distance

(mcm – mm)

Hundreds m and km

$$\mathbf{Ca}^{2+}$$
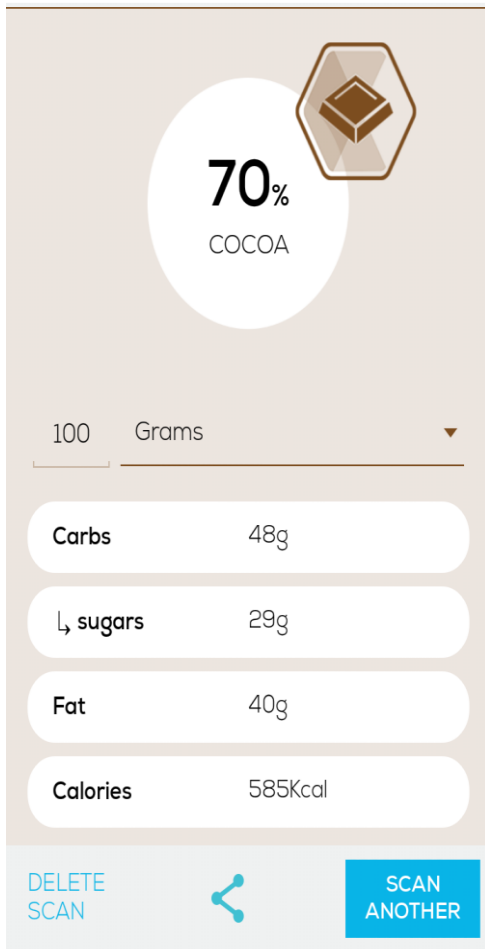
bacteria

pheromones

Micro spectrometer application
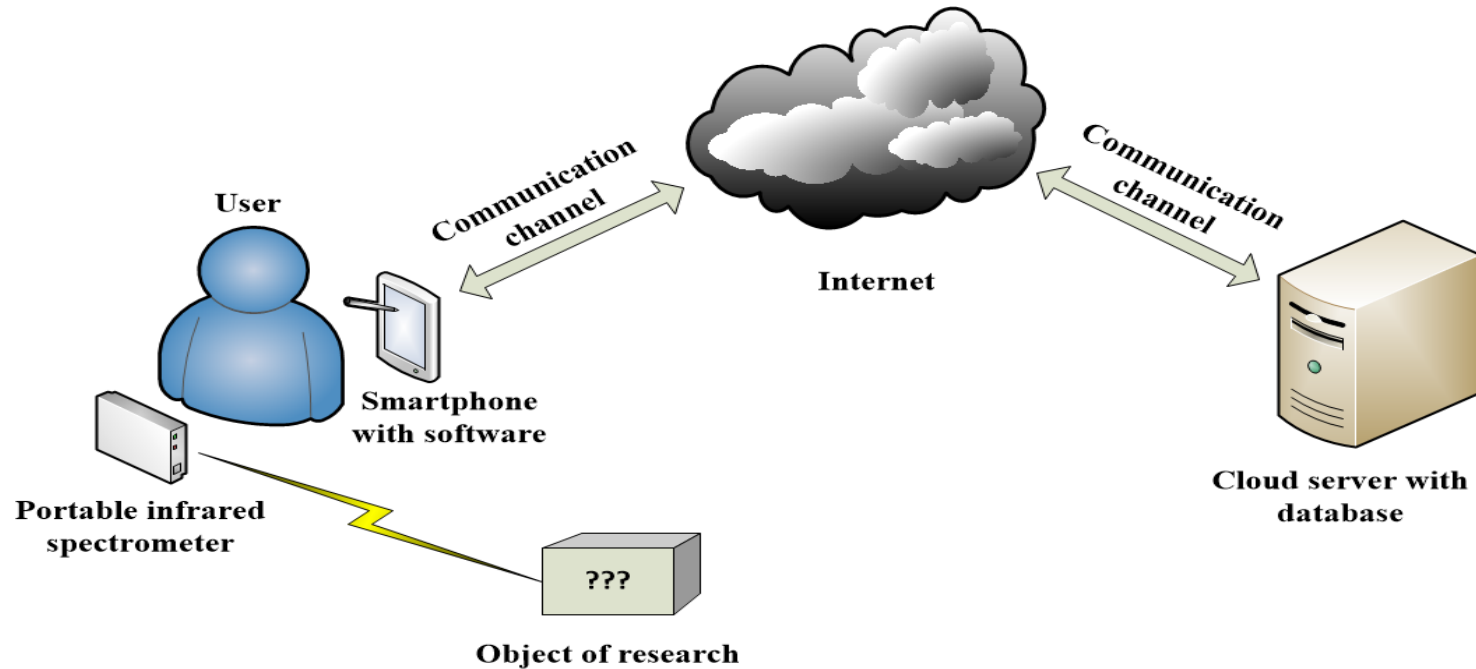
Analysis screen (micro spectrometer SCiO was using)

Traffic analysis

1-2 Mbytes per one spectrogram

Conclusions

1. The route of the shortest length can no longer be considered optimal. The development of new protocols for super dense networks using technologies D2D is required.

2. The network will be decentralized together with implementation of technologies with ultra low latency.

3. There will be many new communications in the networks of 2030, including communications Human-to-Avatar (H2A), Avatar-to-Human (A2H), Avatar-to-Avatar (A2A).

Conclusions (2)

4. It is necessary to take into account in the investigation on networks 2030 the potential of traffic generated by nano networks.