

From IMT-2020 to Network-2030

A.Borodin, SG3 and FG-Net-2030 vice-
chairman, “Rostelecom”,

A.Koucheryavy, SG11 chairman,
SPbSUT/NIIR

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2. D2D Network.
3. Ultra low latency networks.
4. Network clustering and decentralization.
5. Network-2030 vision.
6. Avatar communication.
7. Nano-networks.
8. Conclusions.

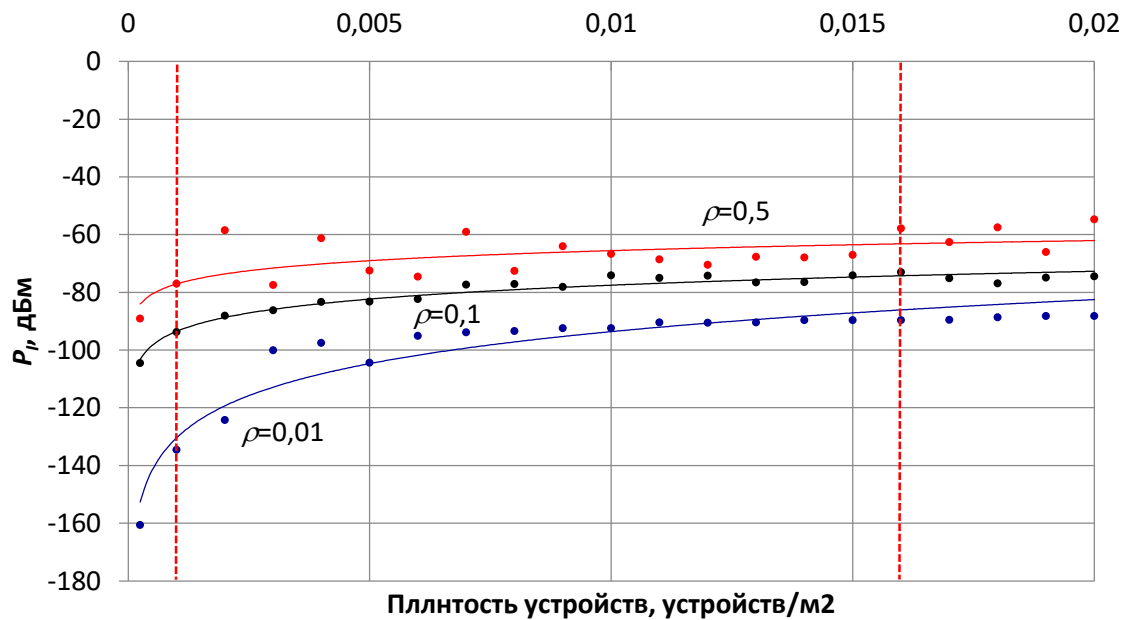
Specific features of IMT-2020 Networks

Super High Dense
Ultra low Latency

Super High Dense Networks

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

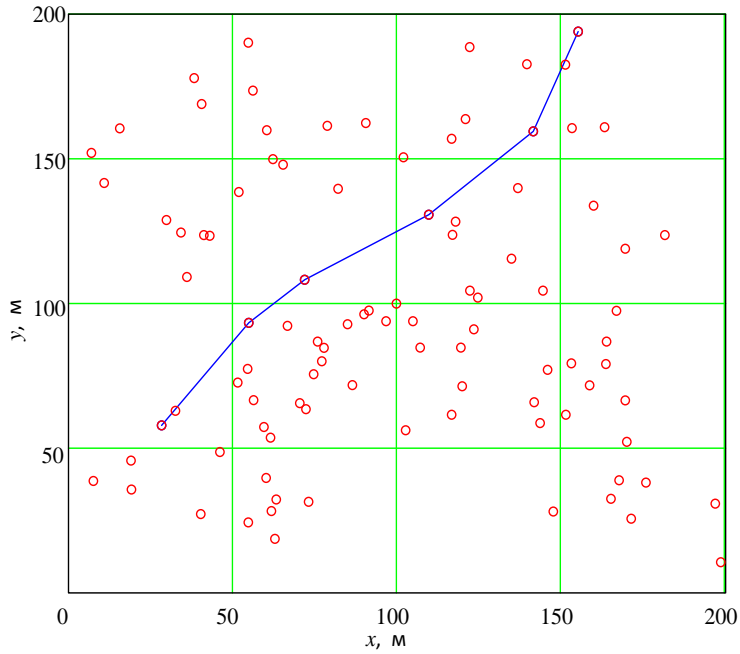
Super High Dense Networks (2)



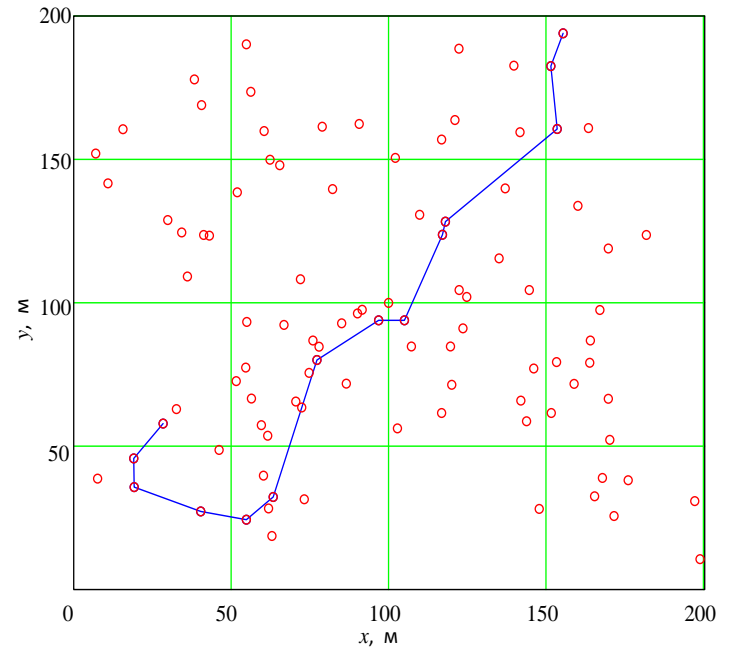
Super High Dense Networks (3)

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

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

$$T = R \times \tau + \Theta,$$

- 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)

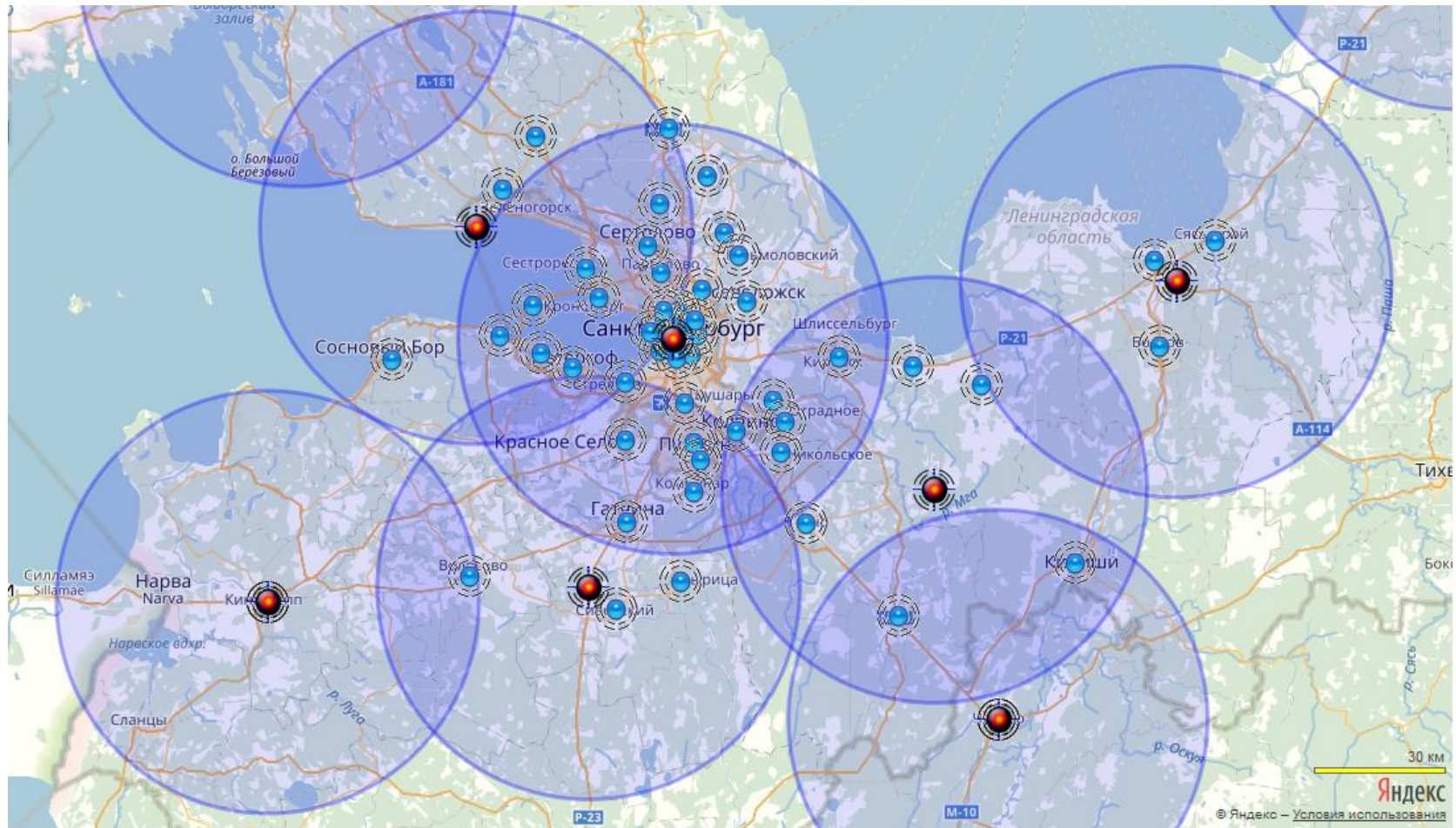
Round Trip Latency, $R=50\text{km}$

Satellite communication - ?

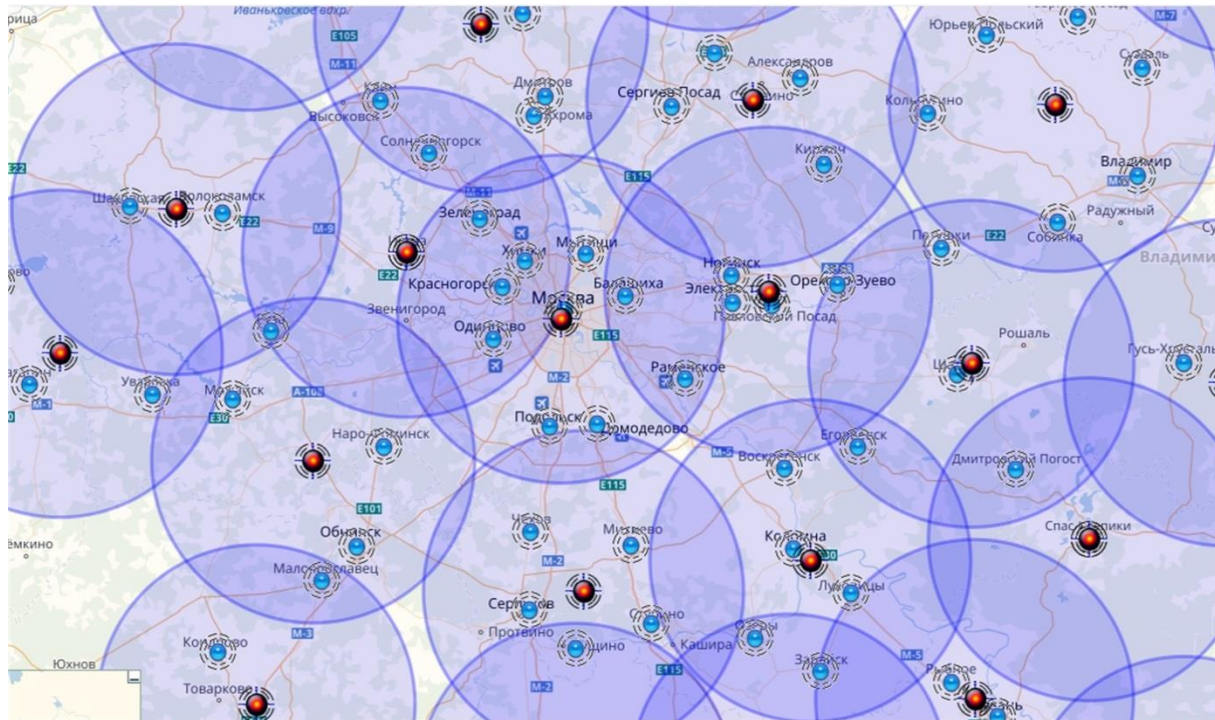
Tethered platforms or tethered UAV's

The network clustering is needed.

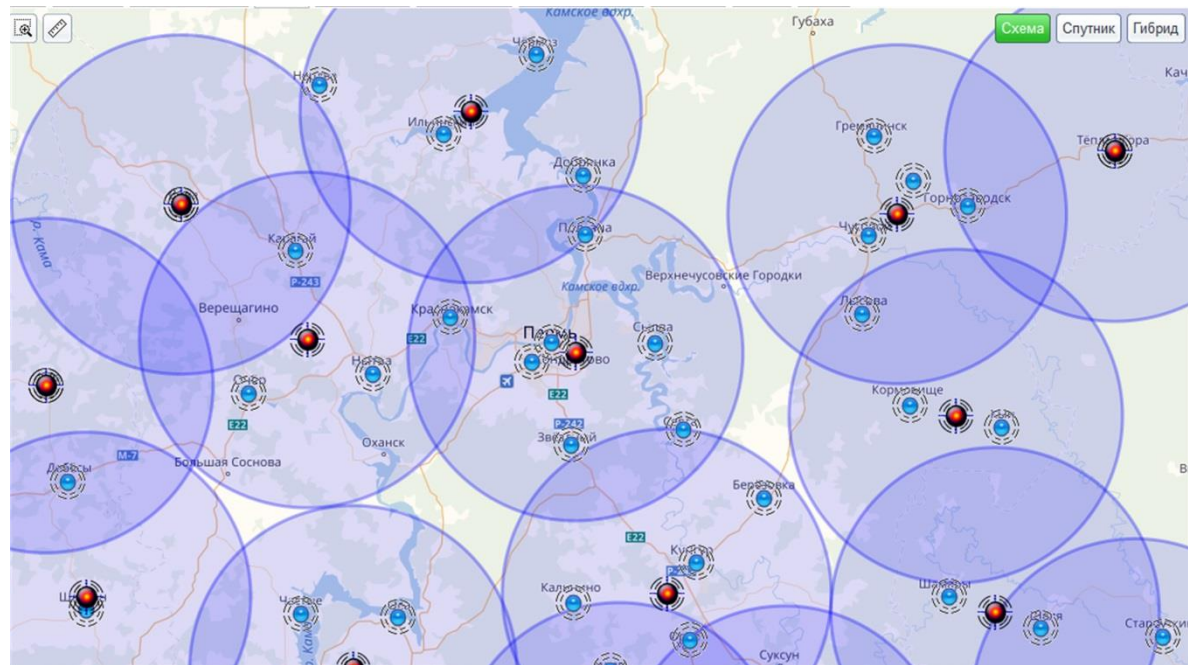
Clustering (Leningrad region)



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



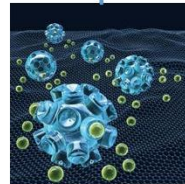
Сеть связи с ультра малыми задержками 2030



Летающие сети



Промышленные гуманоиды

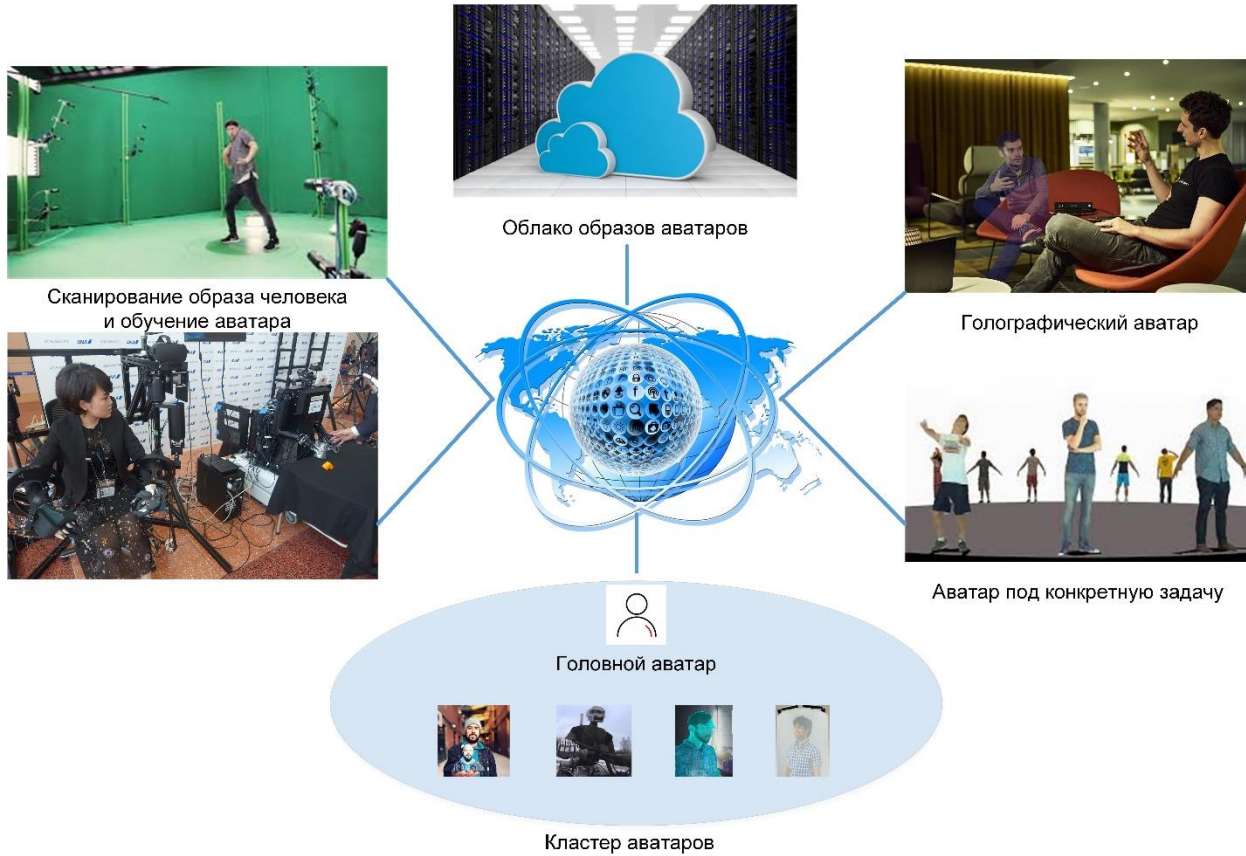


Наносети



Индустрия 4.0

Robots avatars



Avatar communications

Human-to-Avatar (H2A)

Avatar-to-Human (A2H)

Avatar-to-Avatar (A2A).

Nano networks

```
graph TD; WNSN[WNSN] --- Molecular[Molecular]; WNSN --- Electromagnetic[Electromagnetic];
```

WNSN

Molecular

Electromagnetic

Molecular nano networks

The human body,
food (nm – mcm)

Average distance
(mcm – mm)

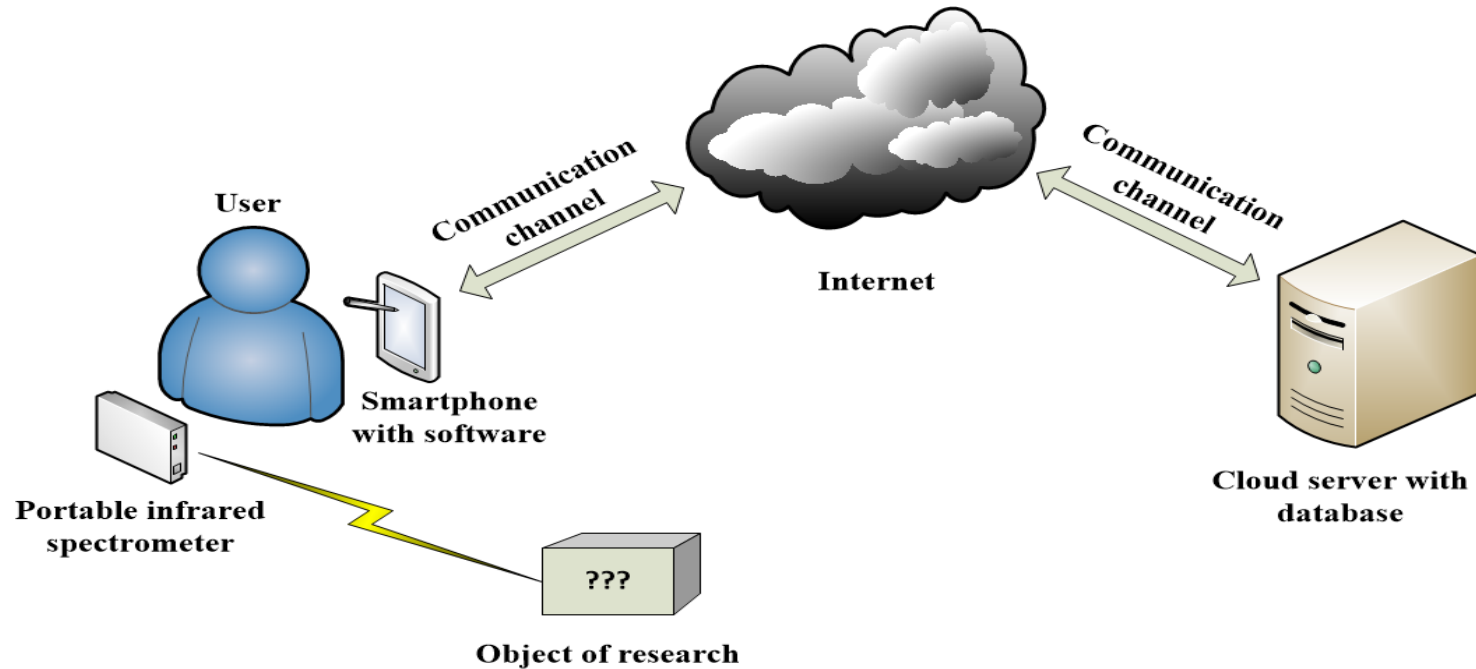
Hundreds m and km



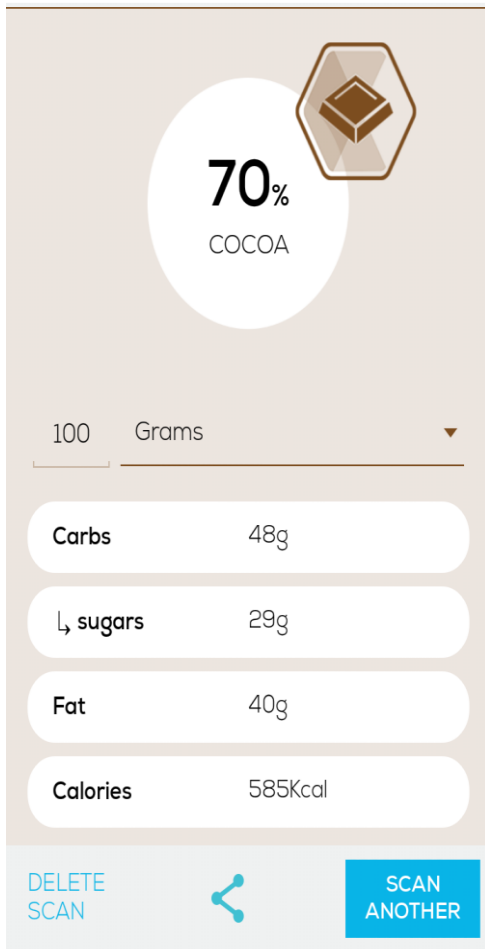
bacteria

pheromones

Micro spectrometer application



Analysis screen (micro spectrometer SCiO was using)



70%
COCOA

100 Grams

Carbs 48g

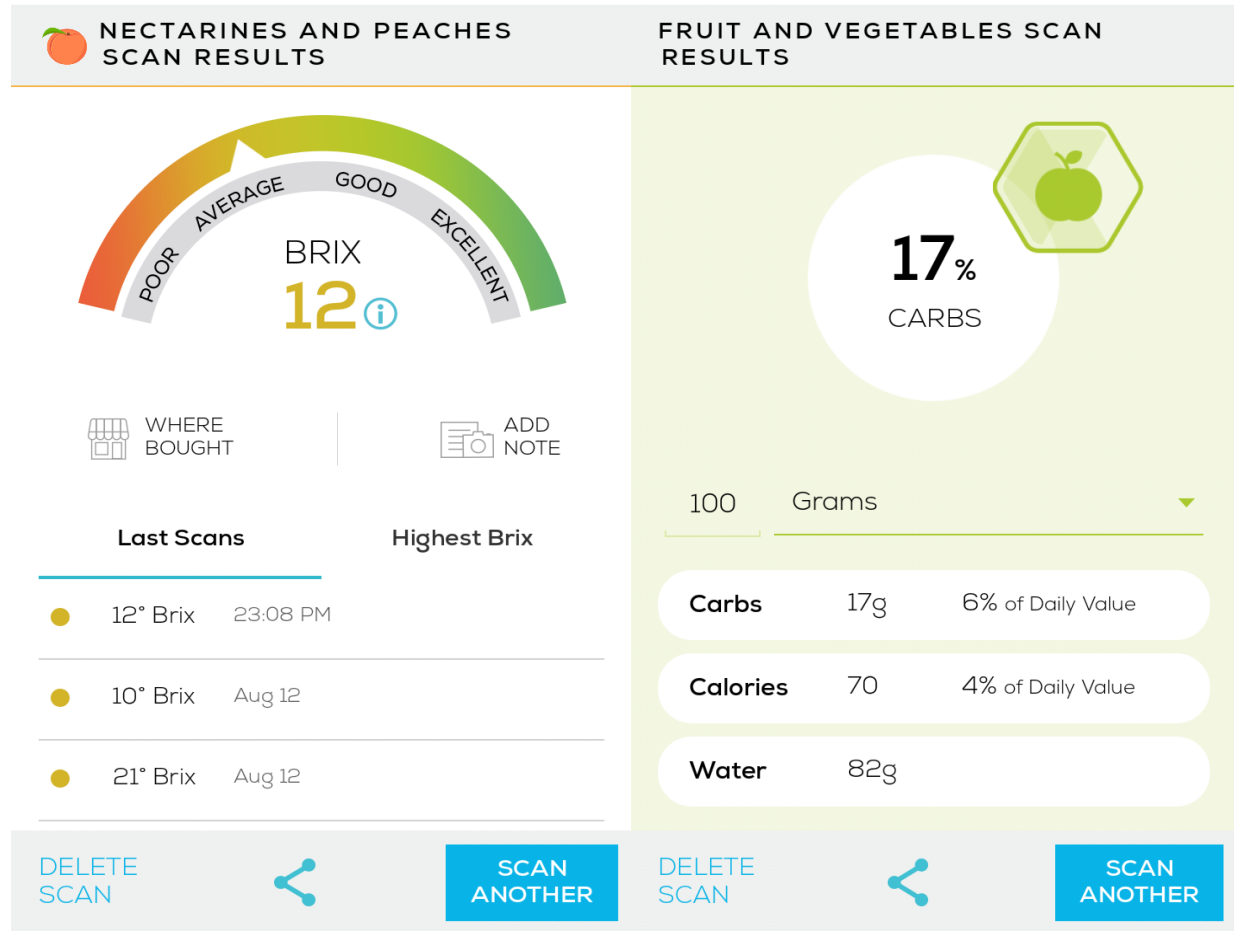
sugars 29g

Fat 40g

Calories 585Kcal

DELETE SCAN

SCAN ANOTHER



NECTARINES AND PEACHES
SCAN RESULTS

FRUIT AND VEGETABLES SCAN
RESULTS

BRIX 12

POOR AVERAGE GOOD EXCELLENT

WHERE BOUGHT

ADD NOTE

Last Scans

Result	Time
12° Brix	23:08 PM
10° Brix	Aug 12
21° Brix	Aug 12

Highest Brix

17%
CARBS

100 Grams

Carbs 17g 6% of Daily Value

Calories 70 4% of Daily Value

Water 82g

DELETE SCAN

SCAN ANOTHER

DELETE SCAN

SCAN ANOTHER

Traffic analysis

The screenshot shows the Wireshark interface for a file named 'btsnoop_hci.log'. The main packet list pane contains the following data:

No.	Time	Source	Destination	Protocol	Length	Info
42	20.361949	controller	host	HCI_EVT	7	Rcvd Command Complete (LE Clear White List)
43	20.362072	host	controller	HCI_CMD	9	Sent Vendor Command 0x0017 (opcode 0xFC17)
44	20.363323	controller	host	HCI_EVT	8	Rcvd Command Complete (Vendor Command 0x0017)
45	20.363446	remote ()	localhost (Redmi)	L2CAP	488	Rcvd
46	20.363560	remote ()	localhost (Redmi)	L2CAP	482	Rcvd
47	20.363622	remote ()	localhost (Redmi)	L2CAP	275	Rcvd
48	20.562390	host	controller	HCI_CMD	4	Sent Reset

The packet details pane for the selected packet (45) shows:

- Bluetooth
- Bluetooth HCI H4
- Bluetooth HCI ACL Packet
- Bluetooth L2CAP Protocol
 - Length: 479
 - CID: Reserved (0x000d)
 - Payload: 15000000010058420067d3014304a64324af43d8af860d03...

The packet bytes pane shows the raw data in hexadecimal and ASCII. The hexadecimal data is: 02 dc 2e e3 01 df 01 0d 00 15 00 00 00 01 00 58 42 00 67 d3 01 43 04 a6 43 24 af 43 d8 af 86 0d 03 95 23 43 00 b0 86 0d 03 67 23 43 00 b0 86 0d 03 67 23 43 28 b0 86 0d 03 67 23 43 28 b0 86 0e 04 67 23 43 4c b0 86 0e 04 67 23 43 70 b0 43 bc b1 43 80 b2 86 36 04 95 13 43 c0 b3 43 88 be 43 d0 bf 43 d4 bf 86 0d 03 3b 23 43 d4 bf 86 0d 03 02 23 43 fc bf 86 0d 03 87 23 43 fc bf 86 0d 03 67 23 43 24 c0 86 0e 04 67 23 43 48 c0 86 0e 04 67 23 43 6c c0 86 36 04 67 13 43 0c c1 43 10 c1 86 38 04 08 63 43 a0 c1 43 d8 cd 43 04 ce 86 36

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.