Sensoru tīkls virsmas formas notiekšanai jeb “Gudrais audums”

(Aprobēta tehnoloģija)

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Būtība:

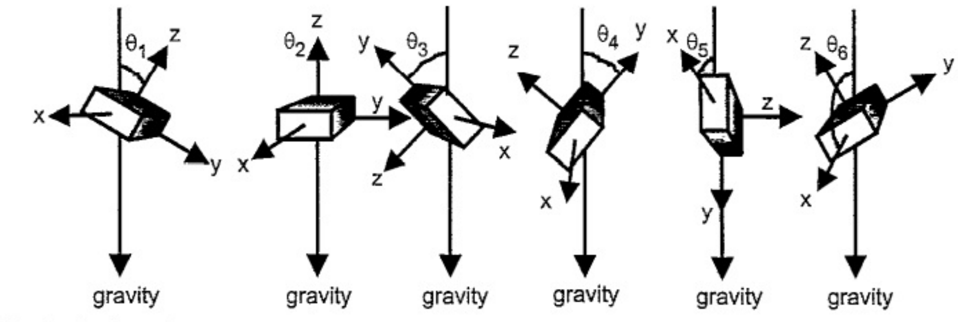
Audums, kuram ar iestrādātu sensoru palīdzību iespējams iegūt ģeometrisku 3D modeli

Pielietojumi:

- Cilvēka pozas mērīšana
- Bioloģiskā atgriezeniskā saite par cilvēka stāju
- 3D formas datu ieguve
- u.c.

Pielietojumu vīzija

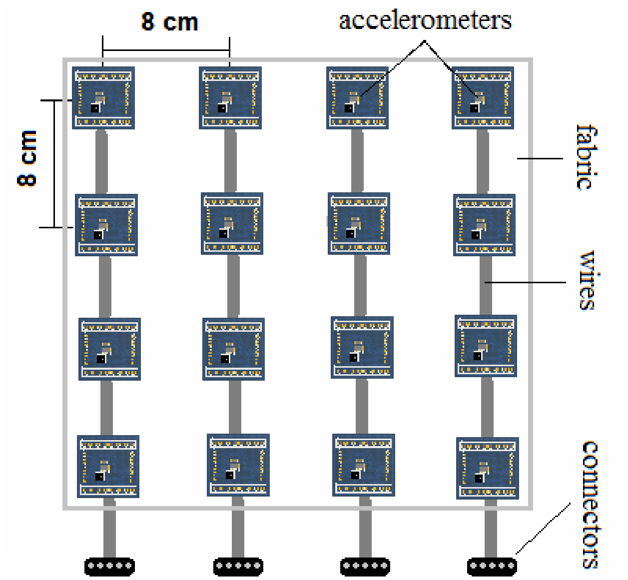
Virsmas noteikšana ar akselerometru tīklu



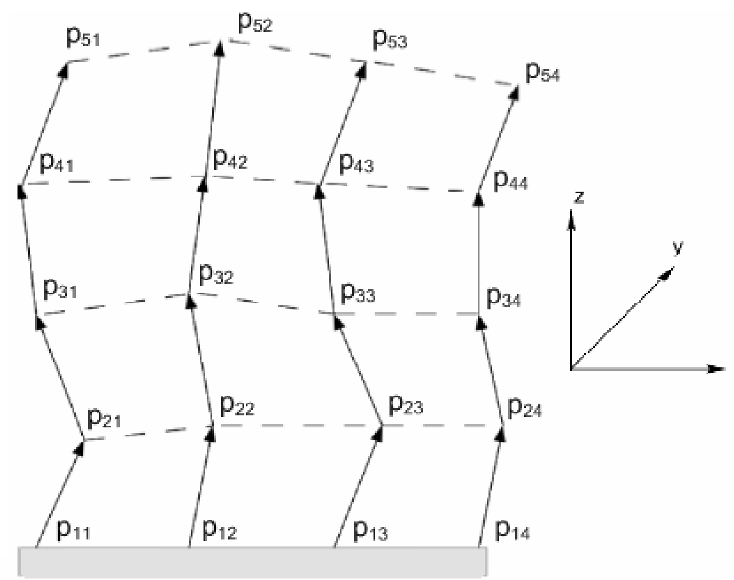
- Miera stāvoklī:

$$\left|\vec{g}\right| = \sqrt{g_x^2 + g_y^2 + g_z^2}$$

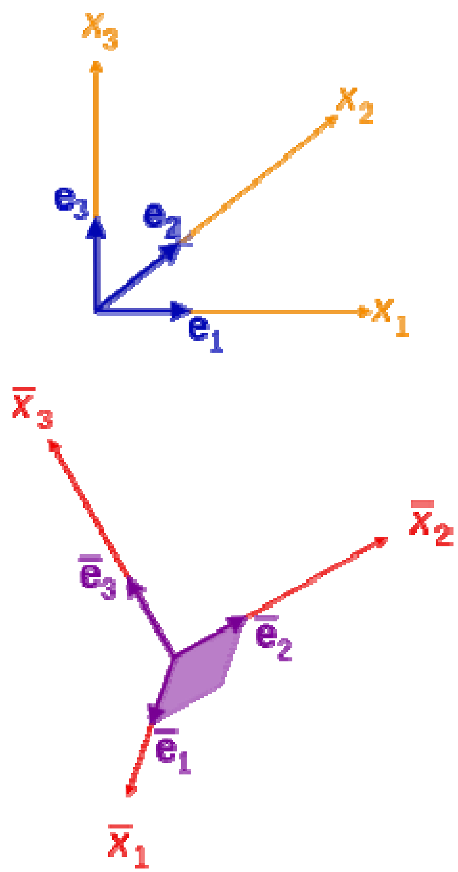
3D akselerometru režģis



Rekonstruētā 3D modeļa struktūra



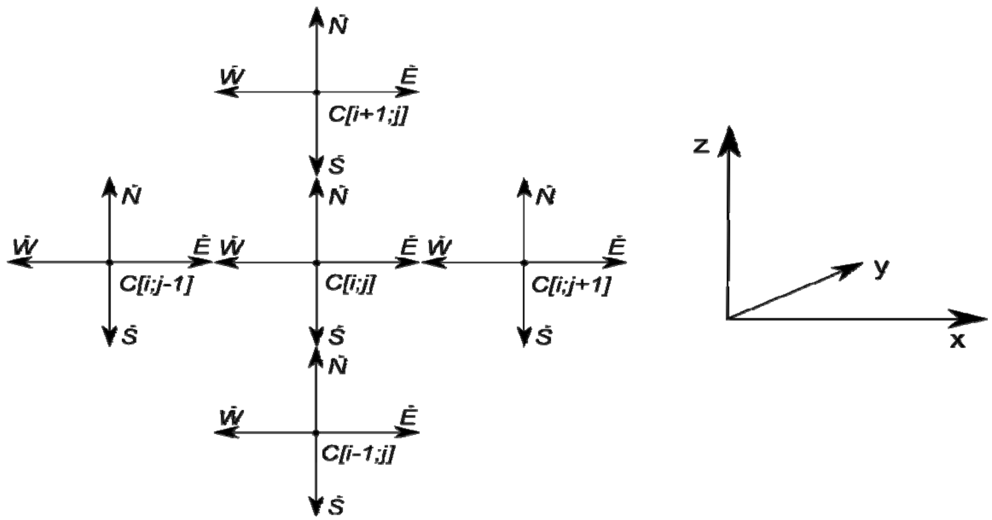
Orientācijas noteikšana ar zemes gravitācijas un magnētiskā lauka mērījumiem

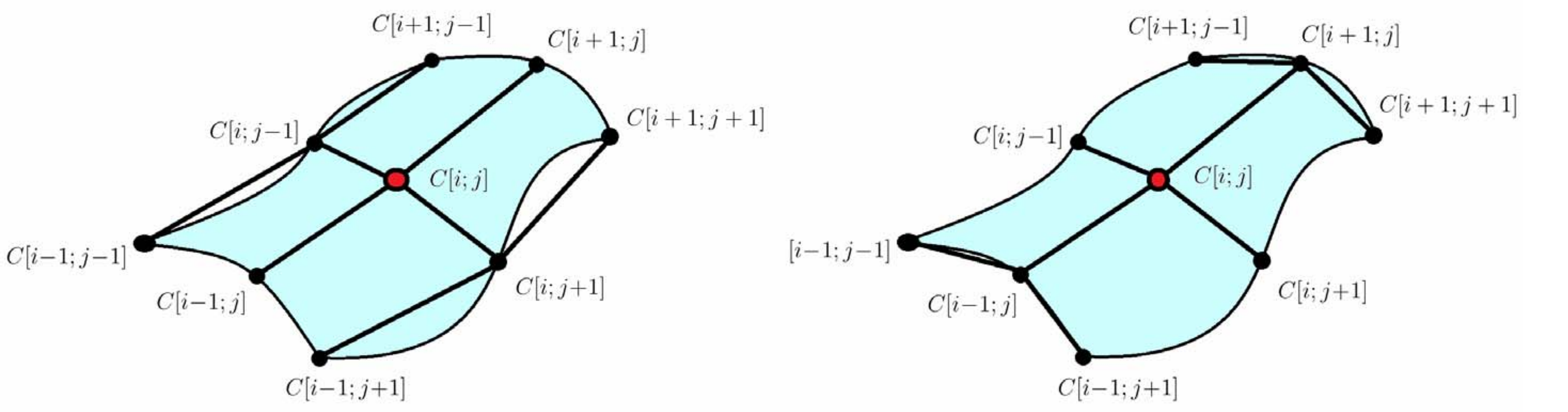


$$\boxed{\begin{aligned} e_1 &= E_g \\ e_2 &= \frac{E_g \times E_m}{E_g \times E_m} \\ e_3 &= e_1 \times e_2, \end{aligned}}$$

$$\boxed{M_e = \begin{bmatrix} e_1 & e_2 & e_3 \end{bmatrix}}$$

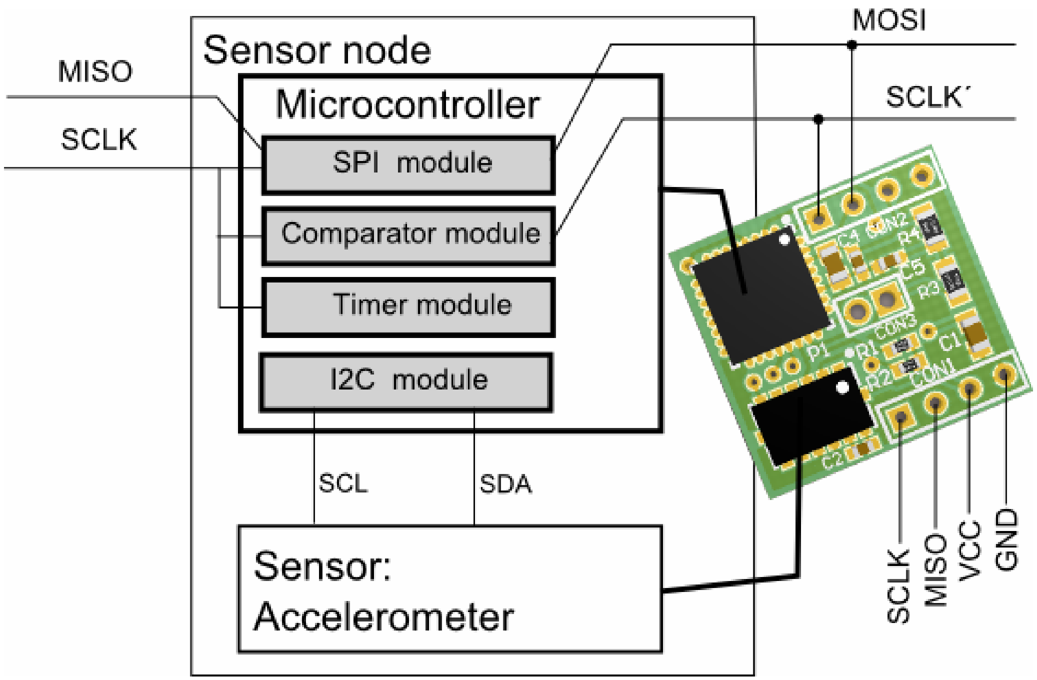
$$\boxed{R = M_e M_s^T}$$


C[i+1;j]
C[i;j-1]
C[i;j]
C[i;j+1]
C[i-1;j]
z
y
x


C[i+1; j−1]
C[i + 1; j]
C[i + 1; j + 1]
C[i; j−1]
C[i; j]
C[i−1; j−1]
C[i−1; j]
C[i; j+1]
C[i−1; j+1]
[i−1; j−1]

(a) (b)

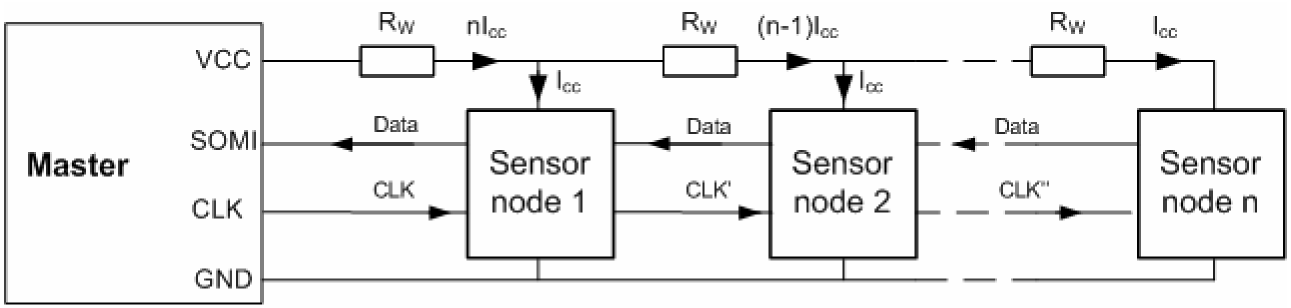
Sensora mezgla uzbūve



Sensors:LSM303DLHC
Mikrokontrolieris: MSP430G2553
Plates izmēri: 13x13x2 mm

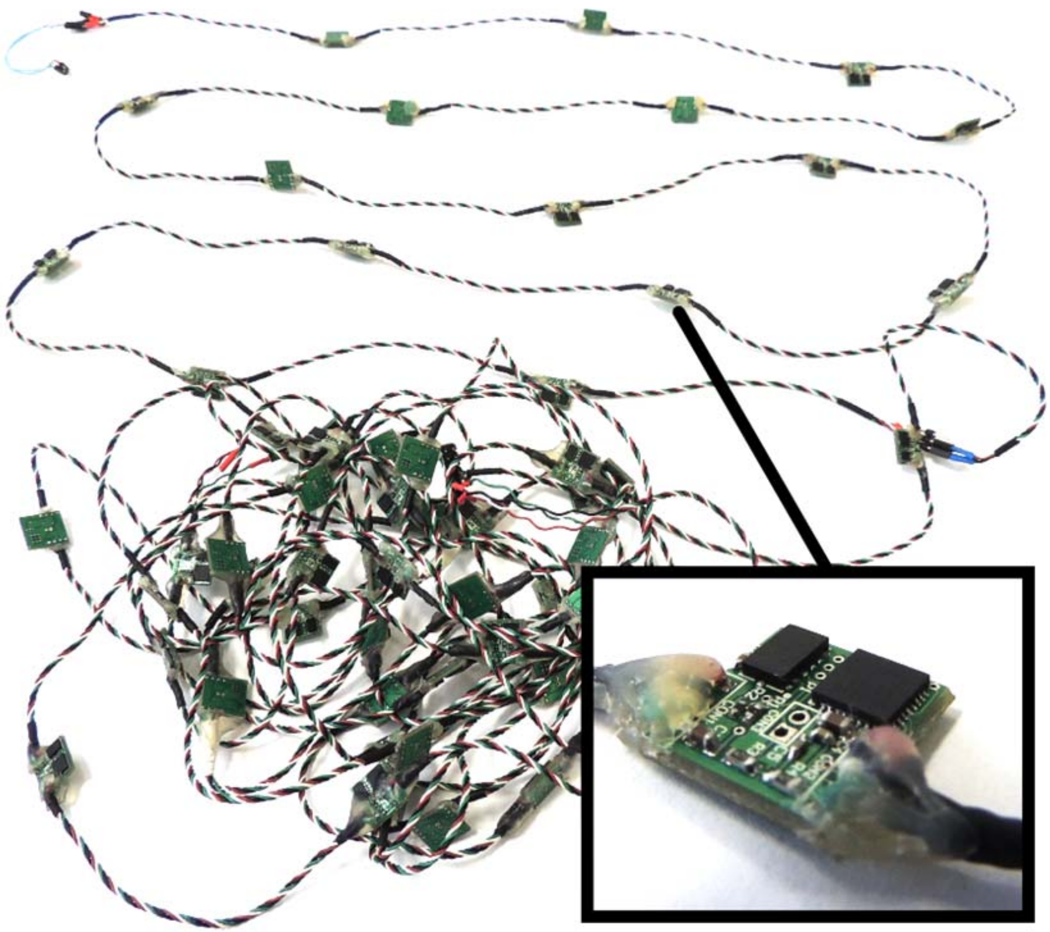
Mikrokontrolieris nodrošina interfeisu starp akselerometriem, kā arī sensoru tīkla topoloģiju, takta signāla atkārtojumu ar integrālo analogo komporatoru, samazinot ārējo komponenšu daudzumu un plates kopējo izmēru.

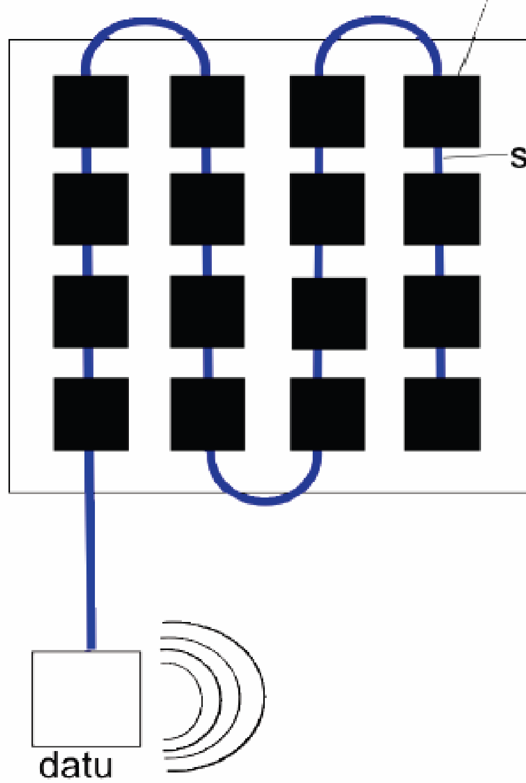
Efektīva datu savākšanas metode

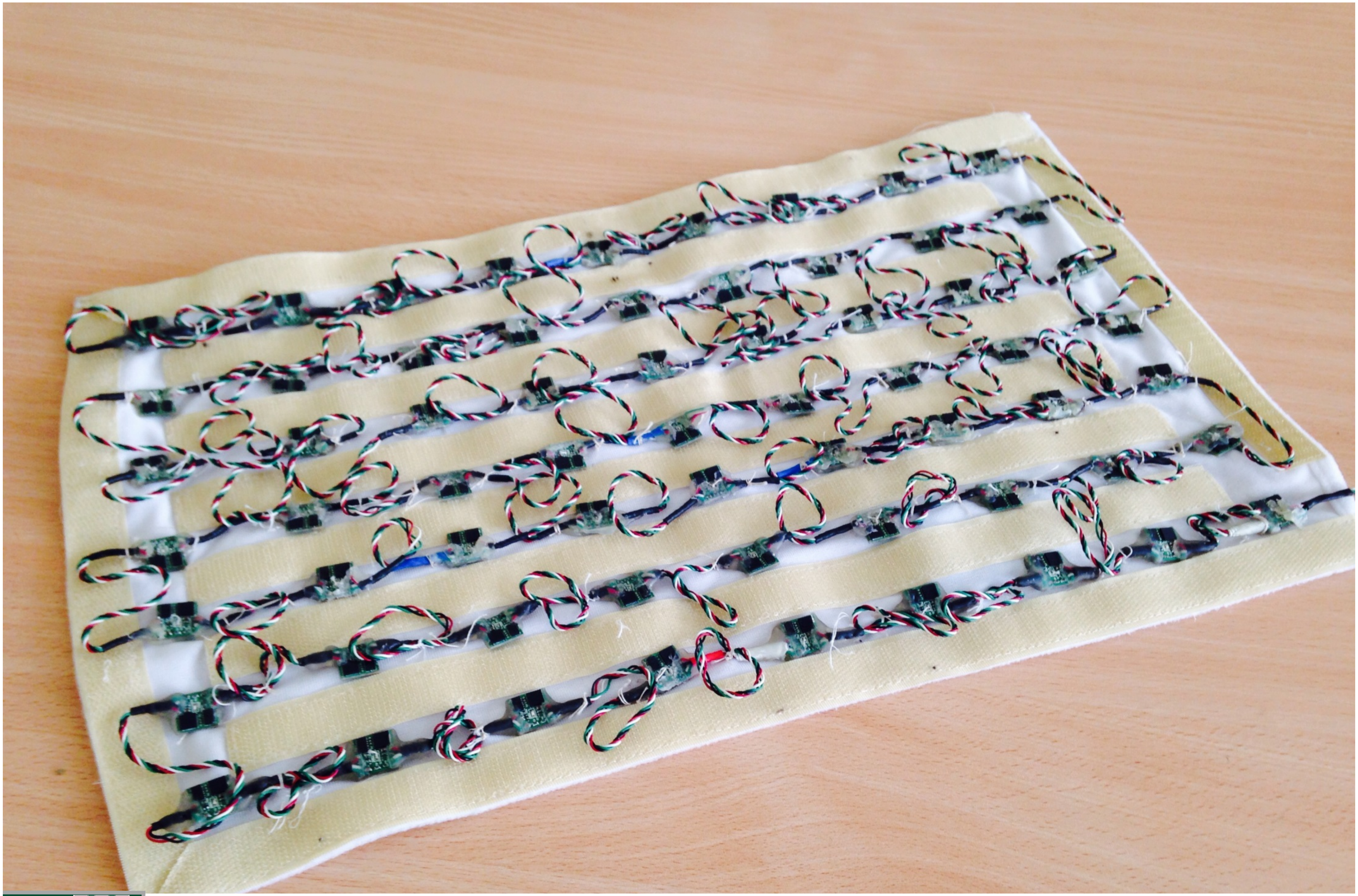


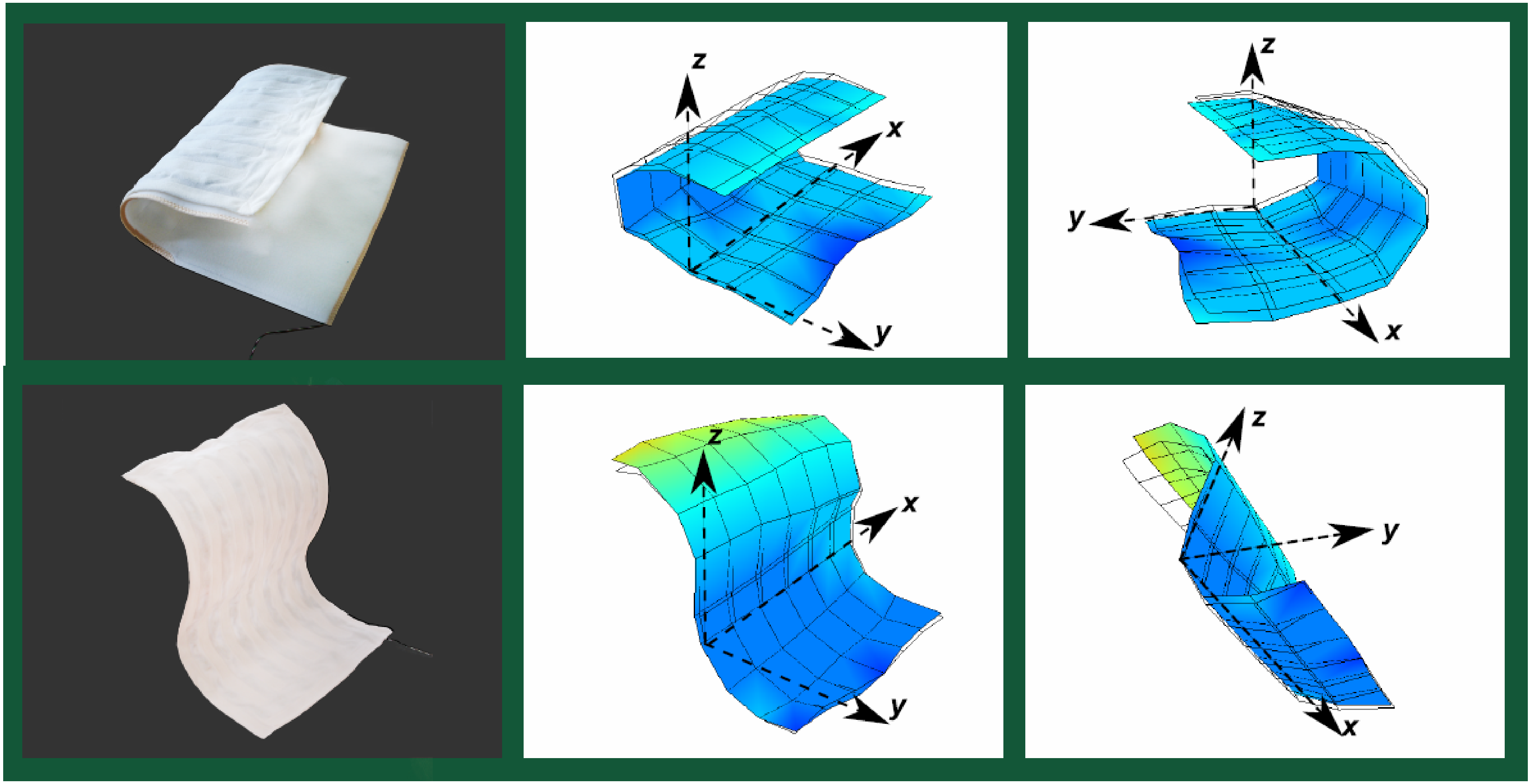
- Metodes pamatā ir SPI virknes slēgums ar modifikācijām;
- Takts signāls tiek atkārtots katrā sensora mezglā;
- Tīkla savienojums ir īstenots ar 4 vadiem;
- Teorētiski, metode atļauj savienot vairākus simtus sensoru mezglu, izmantojot relatīvi nedārgu aparatūru.

Sensoru tīkls

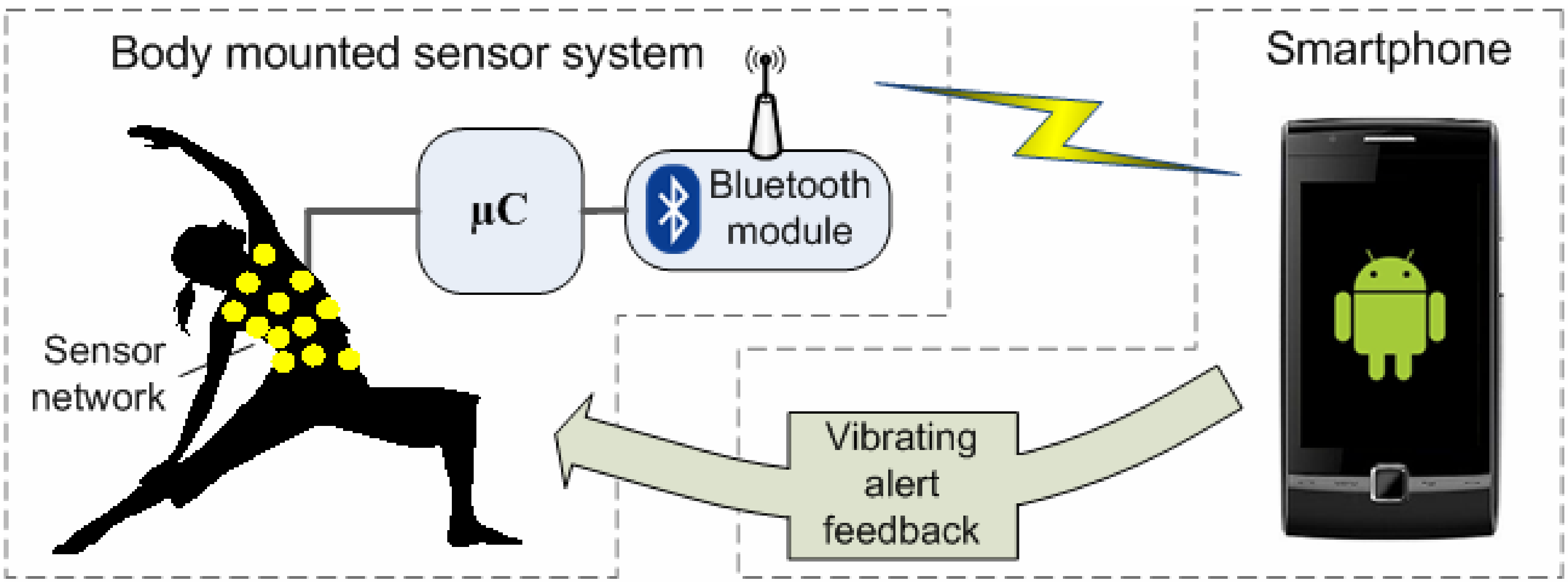




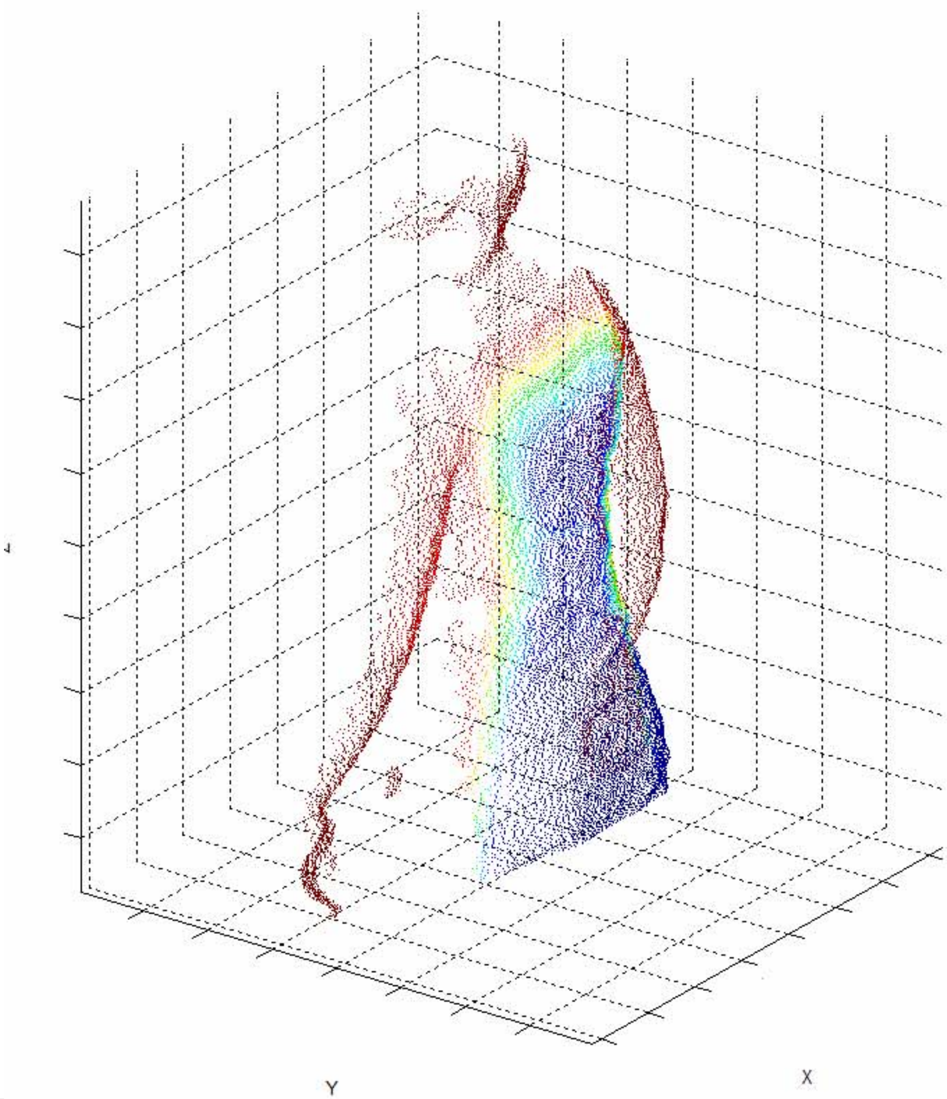



z
x
y
z
y
x
z
x
y
z
y
x

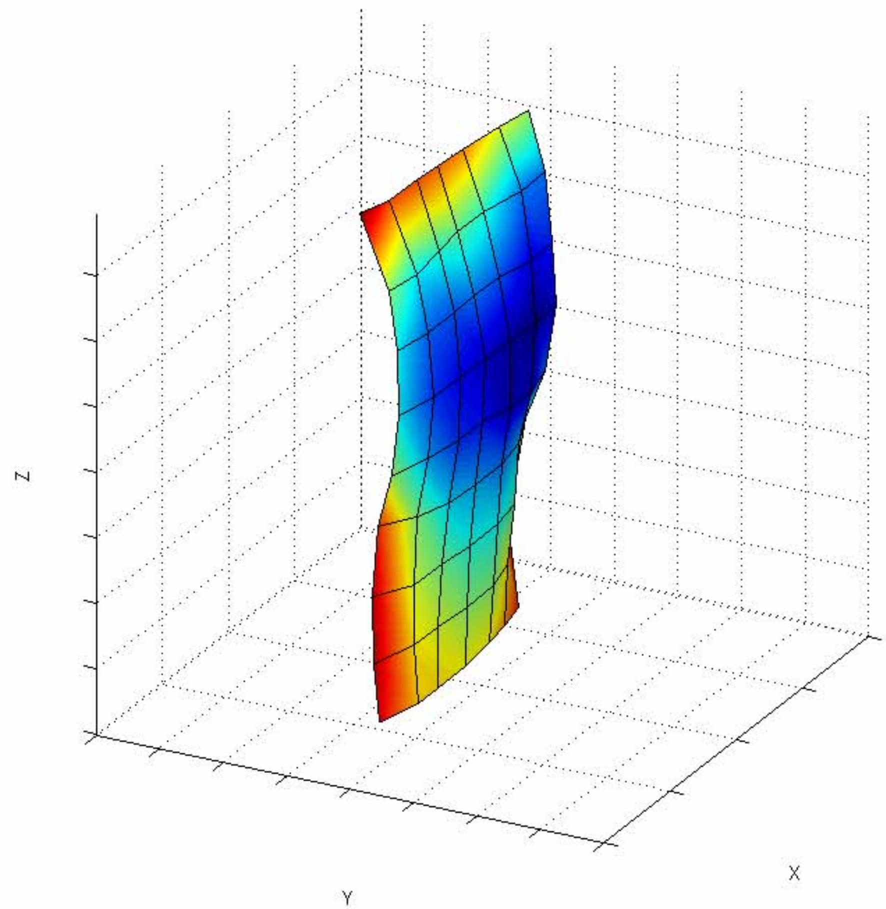
Stājas monitoringa iekārtas struktūra



Kinect sensors



Acc/magn sensoru tīkls



Prototipa aprobācija SIA UniHaus

• Universāls mājās lietojams vingrojumu komplekts;

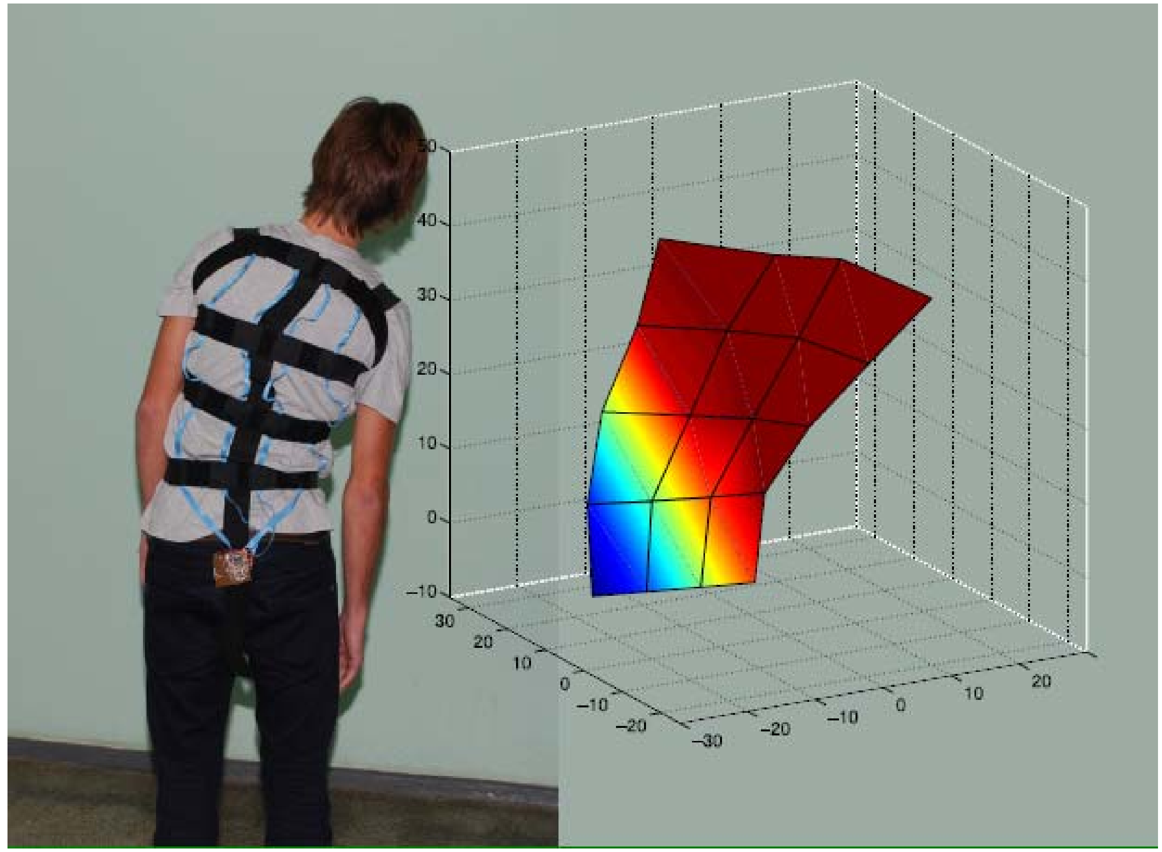
• Alternatīva ķermeņa skeneriem;

• Ērti lietojama un viegli pārnēsājama iekārta;

• Ieteikums palielināt izšķirtspēju;

• Ieteikums iestrādāt sistēmu labāk pieguļošās drēbēs, kur būtu noslēpta visa elektronika;

• Ieteikums uzlabot lietotnes interfeisu.



Aprobācija rehabilitācijas centrā “Mēs esam līdzās”

- Sistēma iestrādāta ortozē, kuru izstrādāja SIA Tonus Elast;
- Rehabilitācijas palīgierīce bērniem ar Cerebrālo Trieku;
- Kustību monitorings bērniem ar pavājinātu rumpja un augšējo muskuļu grupas tonusu;
- Pacienta progresa novērošana:
- Kopīgi aprobācijas rezultāti publicēti 25tajā *European Academy of Childhood Disability* konferencē.

Publicētie rezultāti

Publikācijas:

A. Hermanis, R. Cacurs, M. Greitans, “Human pose recovery by smart sensor layer in clothing”. **Plānots iesniegt** žurnālā “Signal Processing Special Issue on Machine Learning and Signal Processing for Human Pose Recovery and Behavior Analysis”.

A. Hermanis, K. Nesenbergs, “Grid shaped accelerometer network for surface shape recognition”, Electronics Conference (BEC), 2012 13th Biennial Baltic, pp.203-206, 2012;

Hermanis, K. Nesenbergs, R. Cacurs, and M. Greitans, “Wearable Posture Monitoring System with Biofeedback via Smartphone”, Journal of Medical and Bioengineering vol. 2, no. 1, pp.40-44, 2013

K. Nesenbergs, A. Hermanis, M. Greitans, “A Method for Segment Based Surface Reconstruction from Discrete Inclination Values”, 17th International Conference ELECTRONICS 2013, Palanga, Lithuania, June 17-19, 2013. 4 lpp.

K. Nesenbergs, A. Hermanis, A. Greitane, M. Greitans, “Virtual Reality Rehabilitation System for Children with Cerebral Palsy”, 25th European Academy of Childhood Disability, Newcastle, England, 10-12 oct, 2013.

Hermanis, R. Cacurs, K. Nesenbergsun M. Greitāns. "Efficient Real-Time Data Acquisition of Wired Sensor Network with Line Topology", 2013 IEEE Conference on Open Systems, Kuching, Malaysia, 2-4 dec., 6lpp.

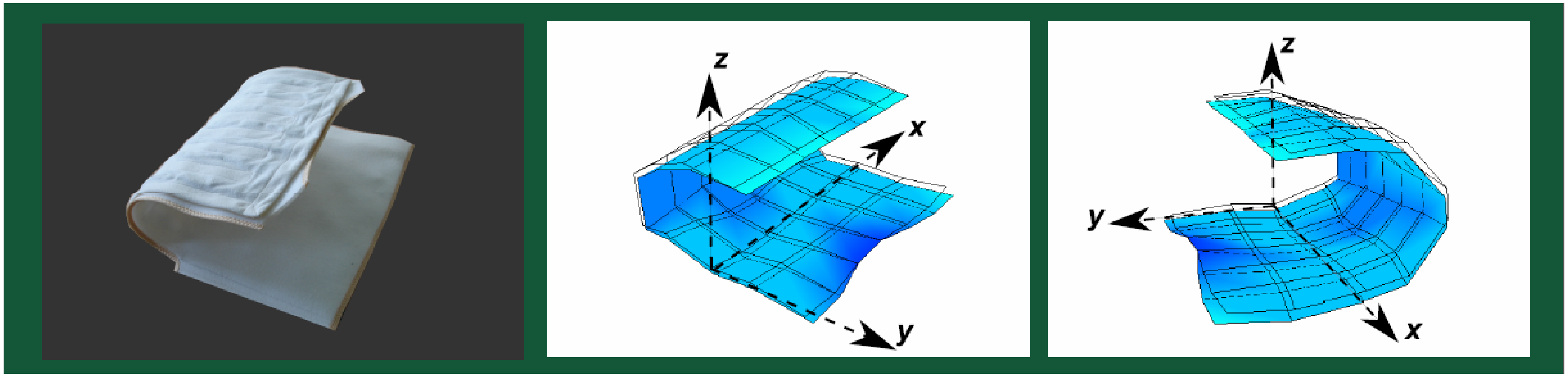
R. Cacurs, “Body Area Sensor Network for Data Processing on Mobile Device”, master’s thesis, RTU, 2013.

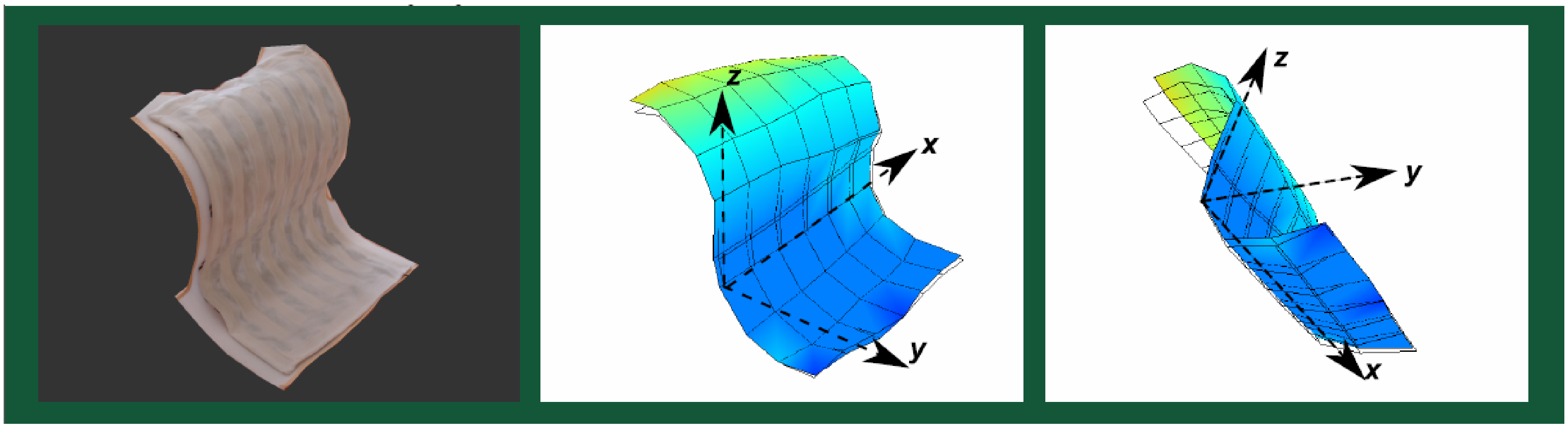
Dalība izstādēs:

Baltijas Modes Federācijas rīkotā izstāde “Inovācijas modes un tekstila industrijā” , Latvijas Mākslas akadēmijā.

Starptautiskā izgudrojumu izstāde MINOX 2013, Rīga

Inovatīvās elektronikas izstāde “Productronica 2013”, Mīnhene, Vācija.





Paldies par uzmanību!

ELEKTRONIKAS UN DATORZINĀTŅU INSTITŪTS

INSTITUTE OF ELECTRONICS AND COMPUTER SCIENCE

Bezkontakta impulsveida tuvdarbības radarsistēma

Rūdolfs Cīrulis
rudolfs.cirulis@edi.lv

Mērķis

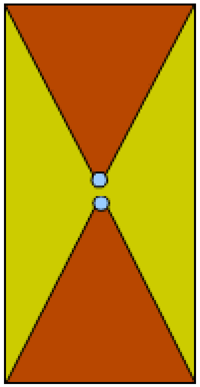
- Izveidot impulsveida radara sistēmu, kas būtu piemērota zemes virskārtas neinvazīvai apsekošanai

Prasības:

- Lokālu objektu noteikšana līdz 2m dziļumam
- Zemes virsējo slāņu biezuma noteikšana
- Izskalojumu/dobumu noteikšana

Bezkontakta antenu izstrāde

Izmantotās antenas



Bowtie antenna

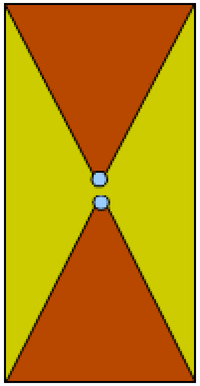
Īpašības:

- Plašs frekvenču diapazons
- Plata virziendiagramma
- Izmantojamas tikai tiešā kontaktā ar zemi

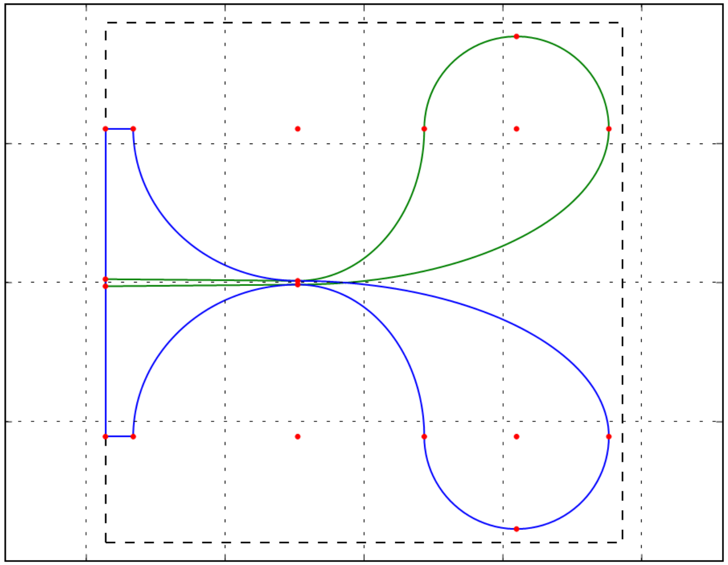
- Nav piemērotas bezkontakta pielietojumam

Bezkontakta antenu izstrāde

Izmantotās antenas

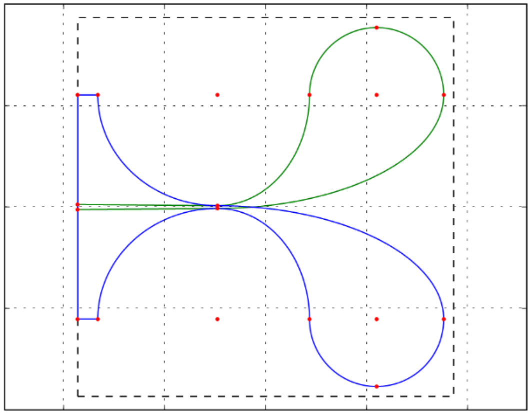


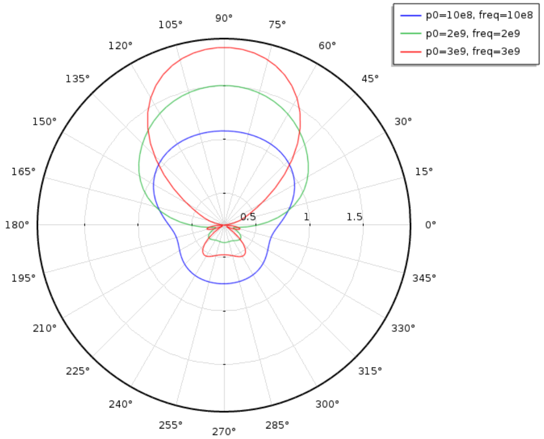
Bowtie antenna

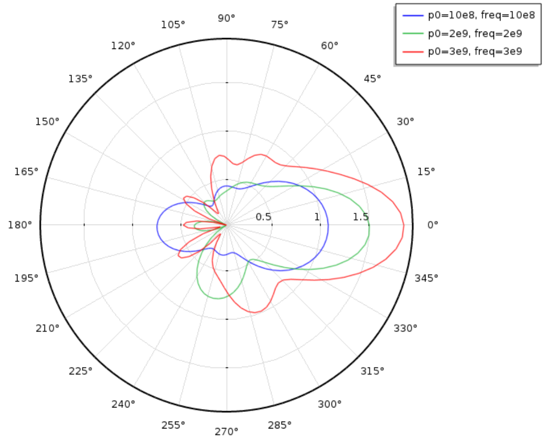


Vivaldi antenna

Bezkontakta antenu izstrāde

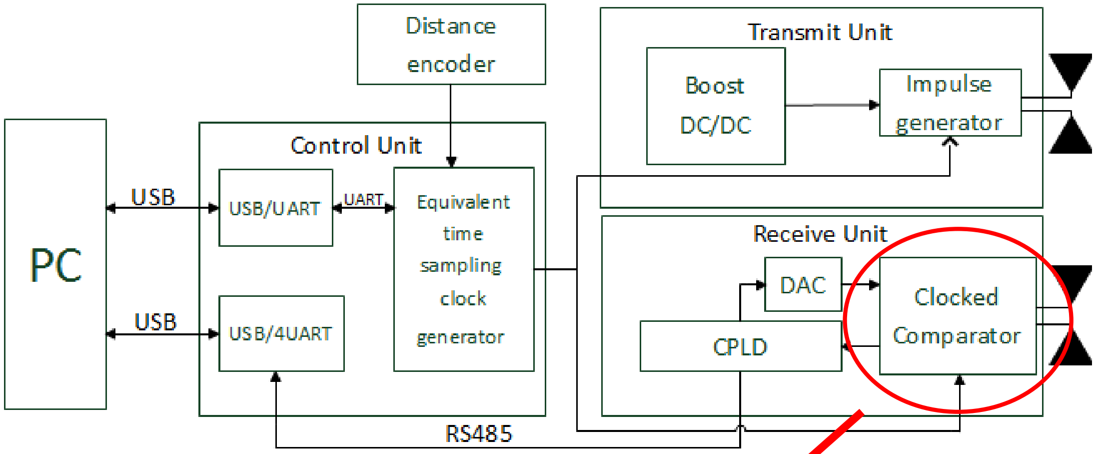






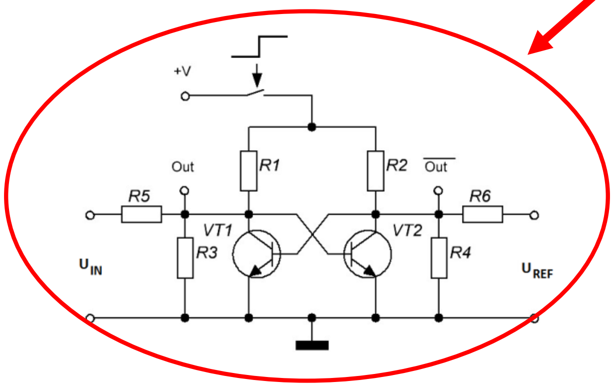
Virziendarbības diagrammas

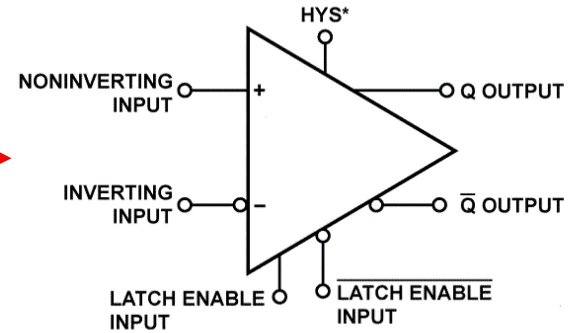
Uztvērēja izstrāde



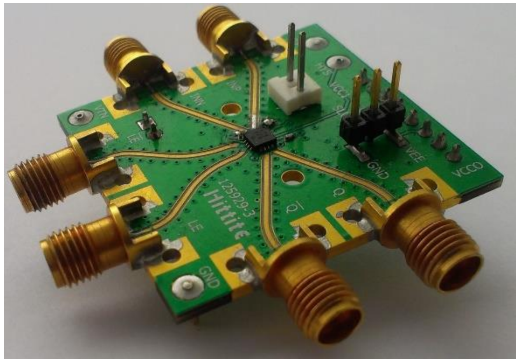
Salīdzinātie parametri

- Frekvenču josla
- Dinamiskais diapazons
- Linearitāte

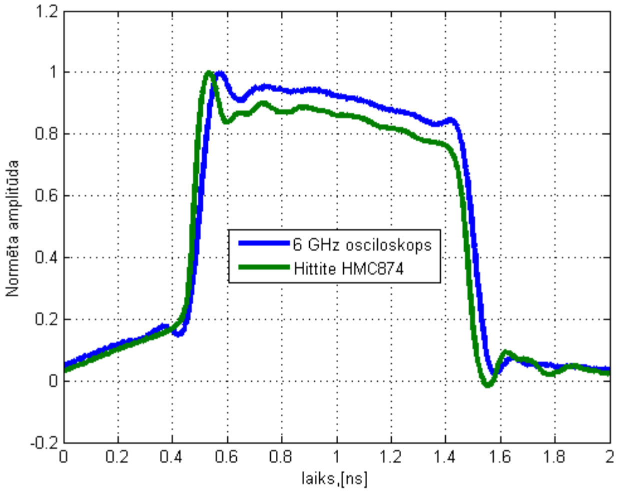


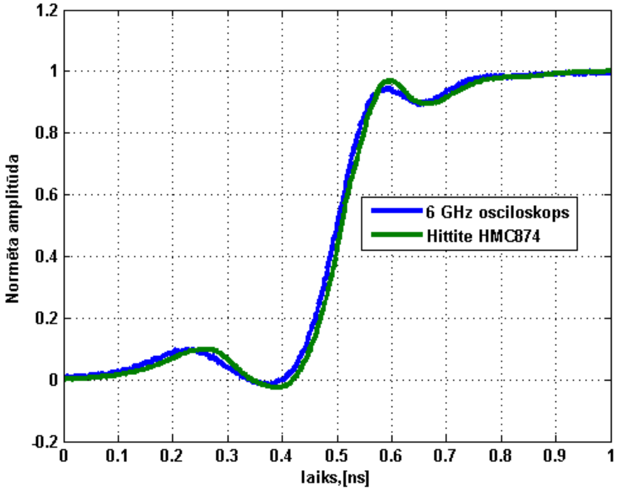


Uztvērēja izstrāde



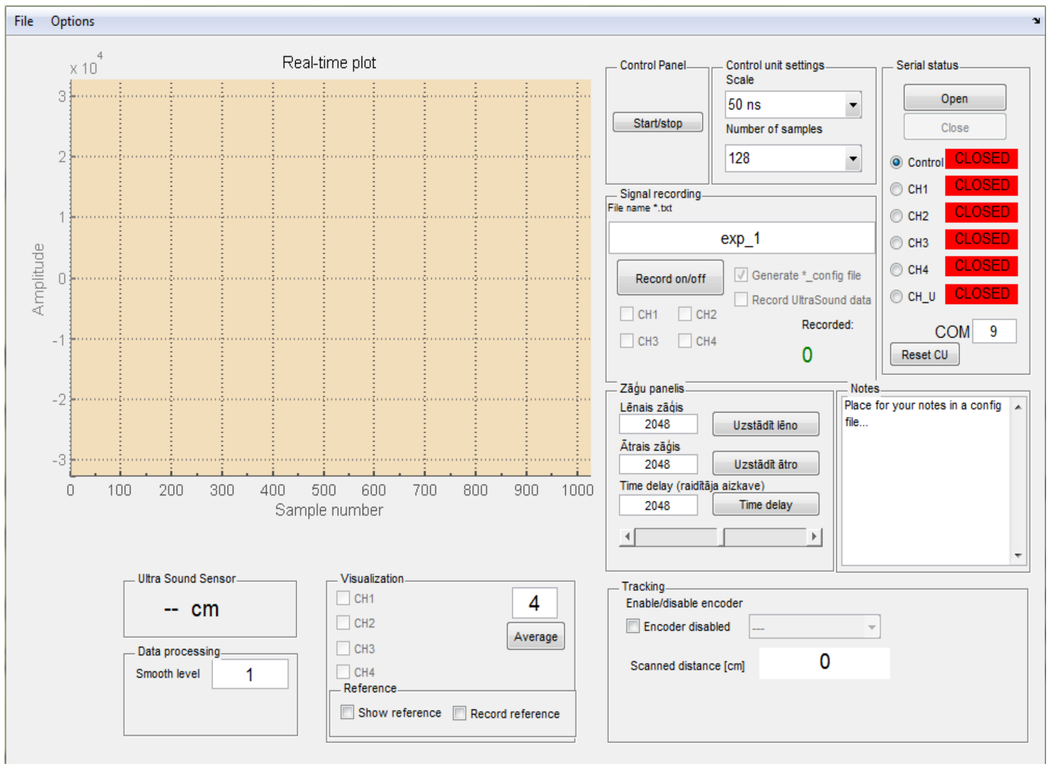
Testa rezultāti ar komparatoru HMC875LC3C



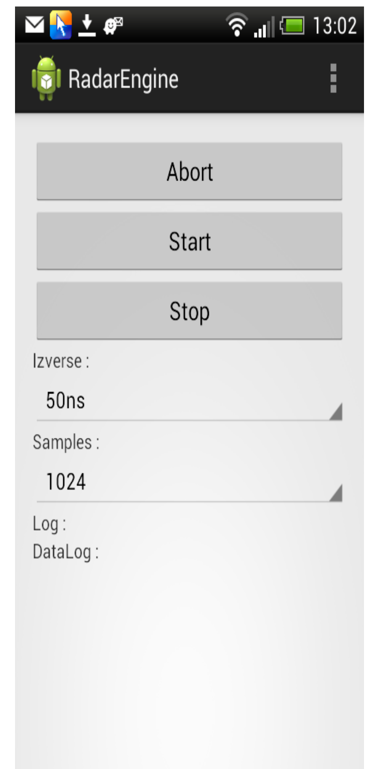


Grafiskās vides interfeiss

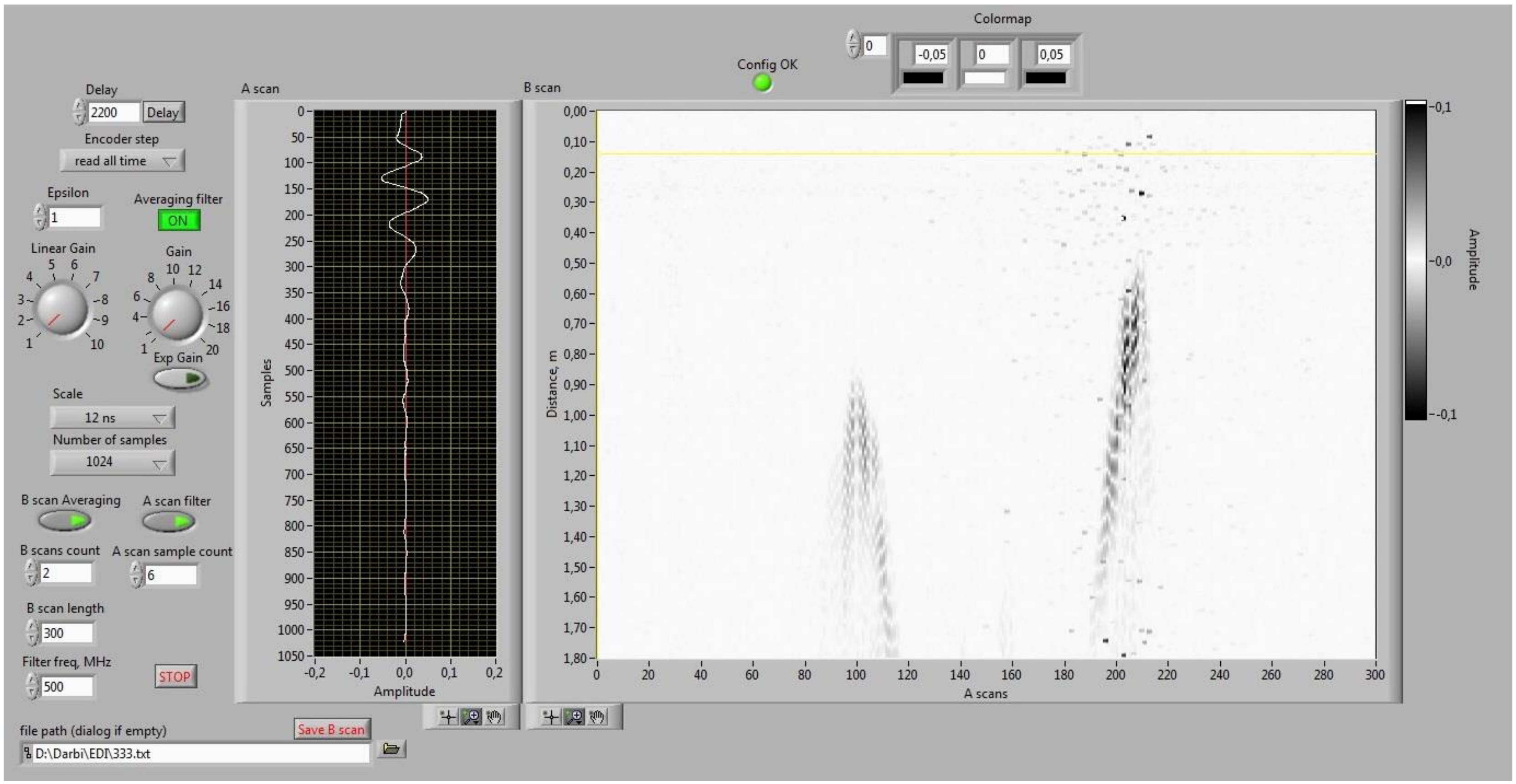
Matlab GUI



Android GUI



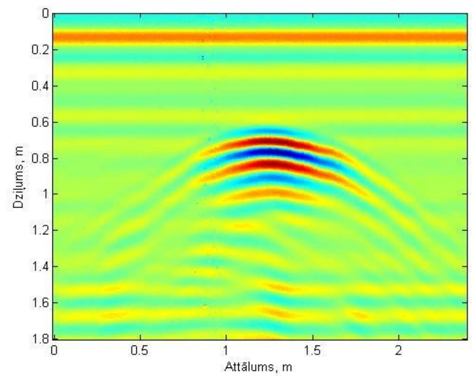
Grafiskās vides interfeiss

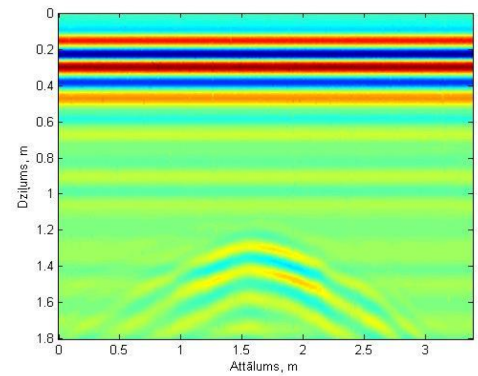


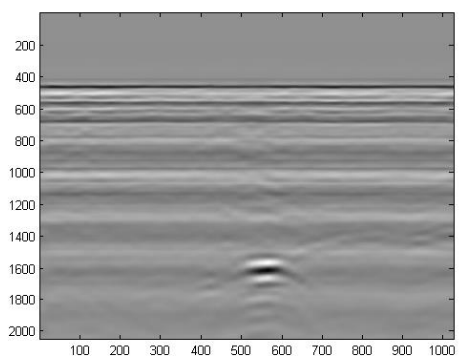
LabVIEW GUI

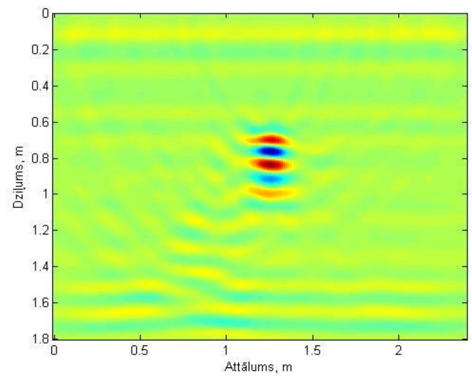
Signālapstrādes algoritmi

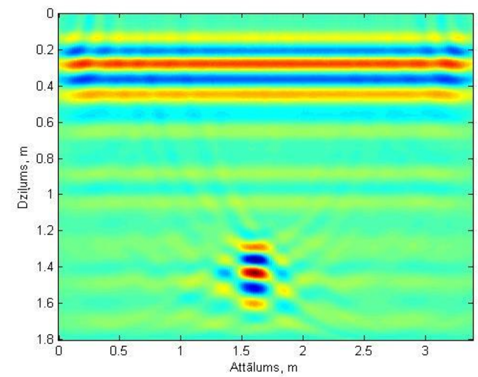
Migrācijas algoritms











Paldies pa uzmanību!
Jautājumi?

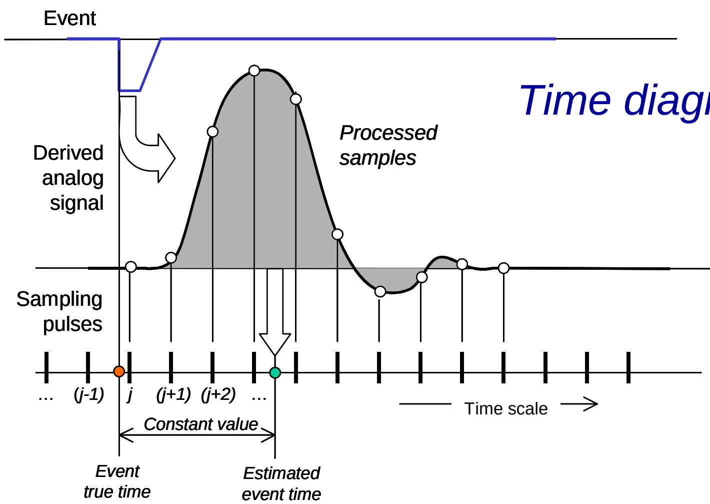
Projekta apakšvirziens:
Ekstrēmi precīzu (pikosekunžu) laika mērījumu sistēmu izveidošana un tās darbības aprobācija tautsaimniecībā

2014.gads:

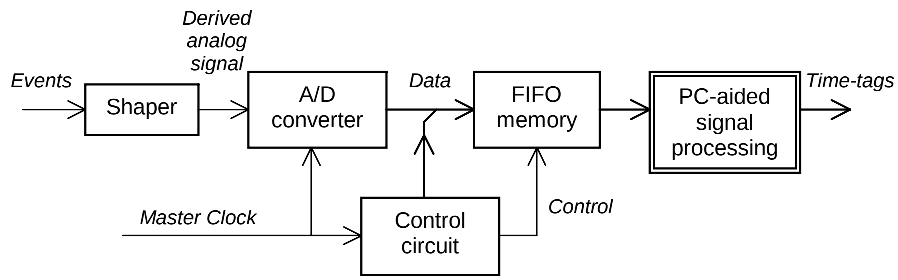
A033-ET/usb laika mērījumu sistēmu izstrāde un to aprobācija reāliem apstākļiem pietuvinātos scenārijos

Laika notikumu reģistrācijas tehnoloģijas pamati un realizācijas (2010 – 2014)

Time diagram



Block diagram



General parameters

Resolution:	**3 ps RMS**
Maximum burst rate:	**20 MSPS**

Event Timer A033-ET

Average rate:	**30 KEPS**
PC interface:	**Parallel Port**
Size; power	**367x90x265; 21 W**

Distinguishing parameters

Event Timer A033-ET/usb

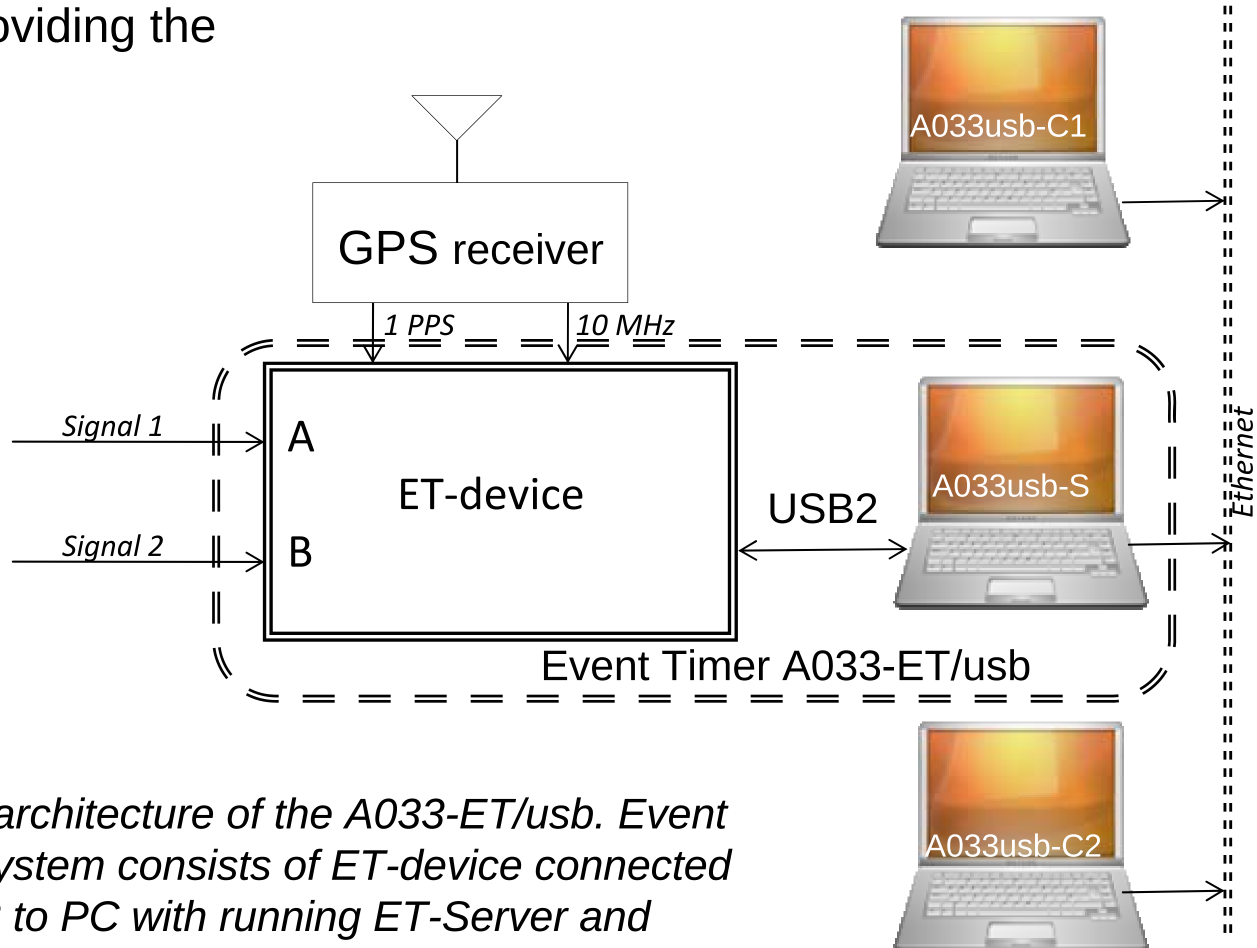
Average rate:	**1100 KEPS**
PC interface:	**USB2**
Size; power	**367x70x265; 24W**

The Eventech Ltd (Latvia) having the Licensee Agreement with IECS for manufacturing and distributing of A033-ET is the main interested party for new A033-ET/usb

Pētījumu galvenie virzieni izpildei 2014. gadā

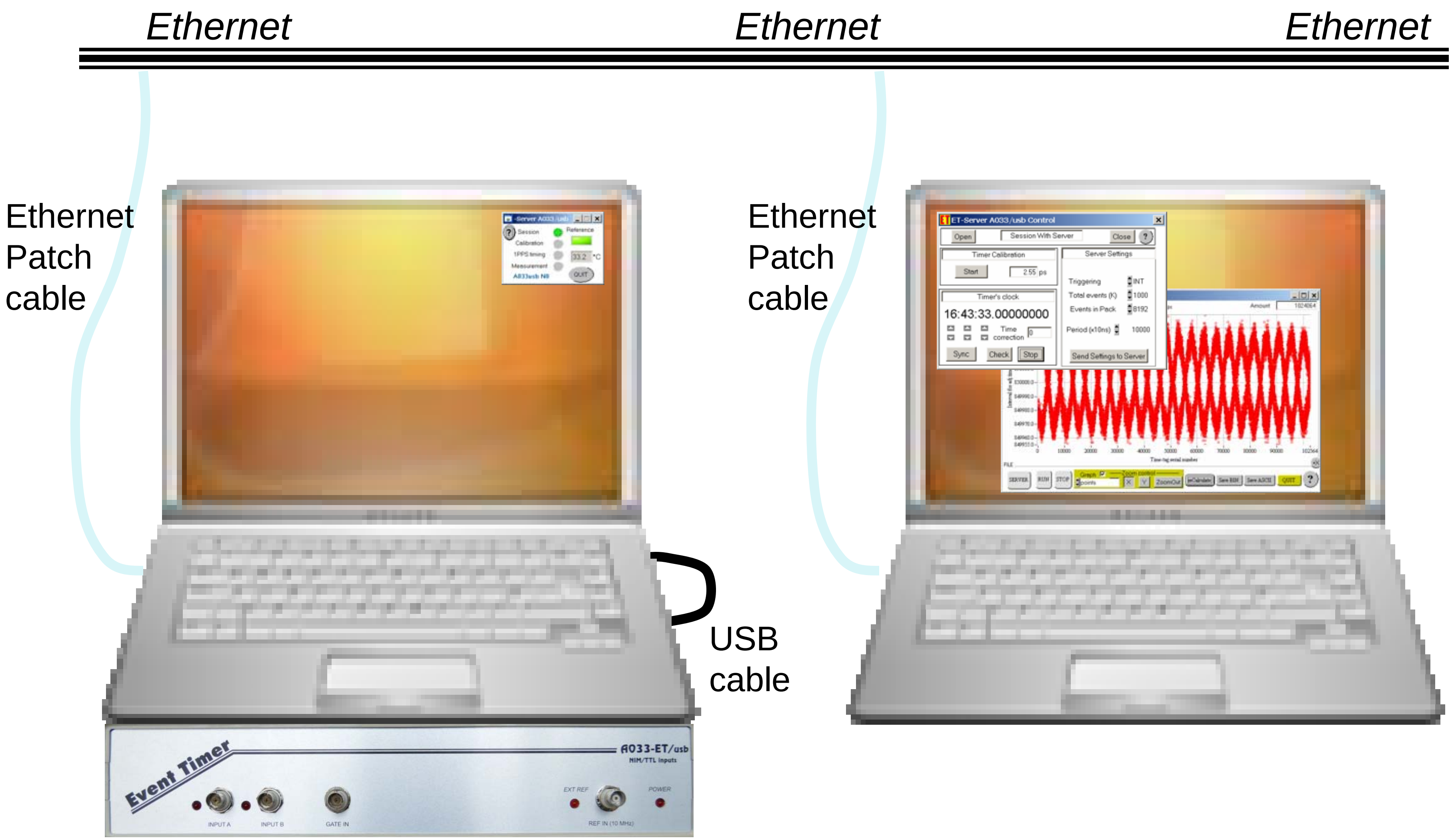
The main object of this year activity was to develop the new Event Timing Systems based on USB2 interface and providing the picosecond resolution

Event Timing System based on the A033-ET/usb



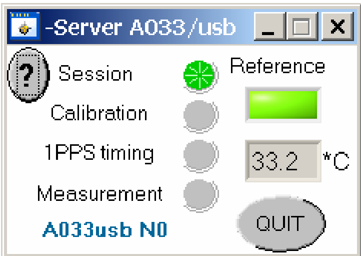
Network architecture of the A033-ET/usb. Event Timing System consists of ET-device connected via USB2 to PC with running ET-Server and network connected PC with running ET-Clients.

Event Timing System based on the A033-ET/usb



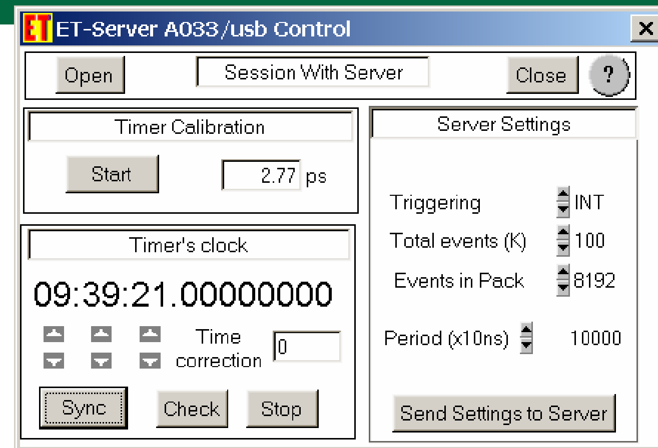
Event Timing System based on the A033-ET/usb

ETusbServer

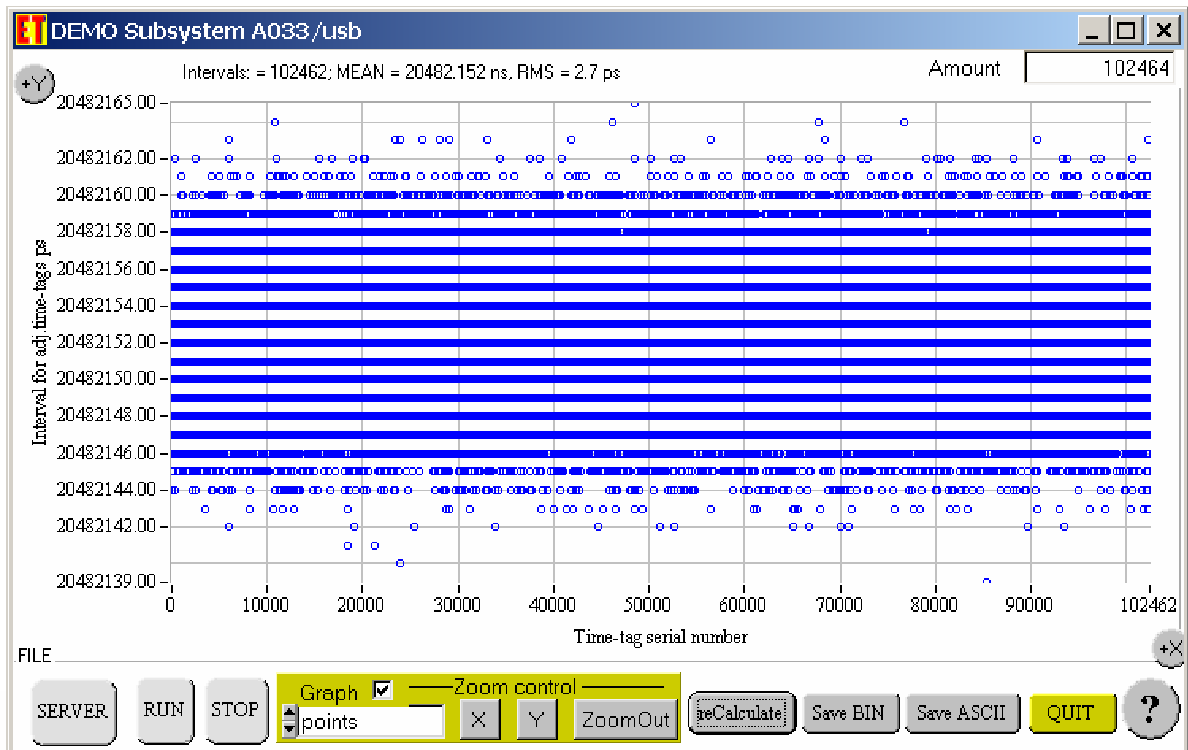


Indicates only activity and information about the ET-device

ETusbClient



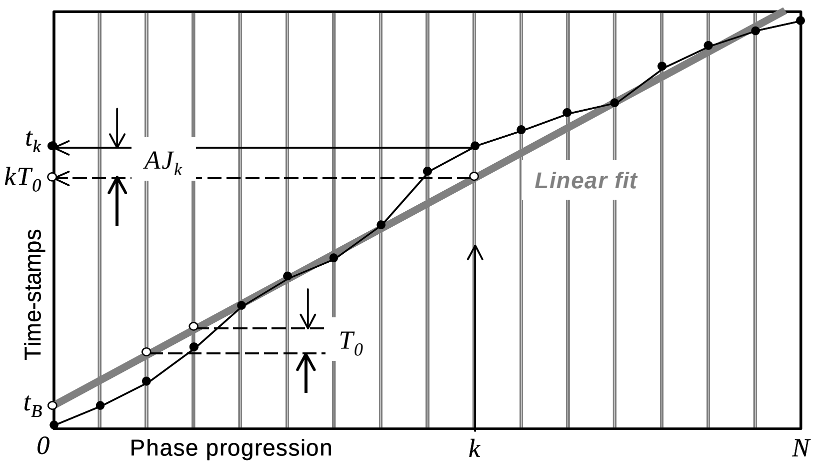
Accessory panel indicates the state of ETS and setting parameters



Presentation panel shows the measurement result as intervals between adjacent time-tags and allows statistic parameters calculation and graph control

Pulse generator jitter analysis

Explicit jitter measurement



accumulated jitter function:

$$AJ_k = t_k - (kT_0 + t_B), \quad k = 0,1,\ldots,N$$

periodic jitter function :

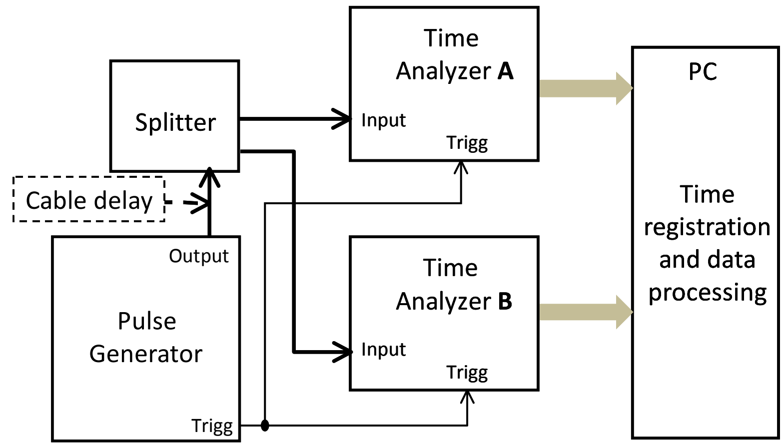
$$PJ_k = AJ_k - AJ_{k-1}; \quad k = 1,2,\ldots,N$$

cycle-to-cycle jitter function :

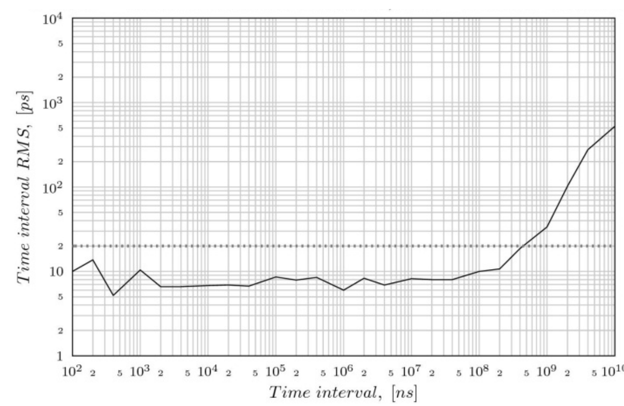
$$CJ_k = PJ_k - PJ_{k-1}; \quad k = 2,3,\ldots,N$$

Jitter functions characterize modulation functions

Implicit jitter measurement



$$D_2[T] = \mathrm{cov}(A, B)$$

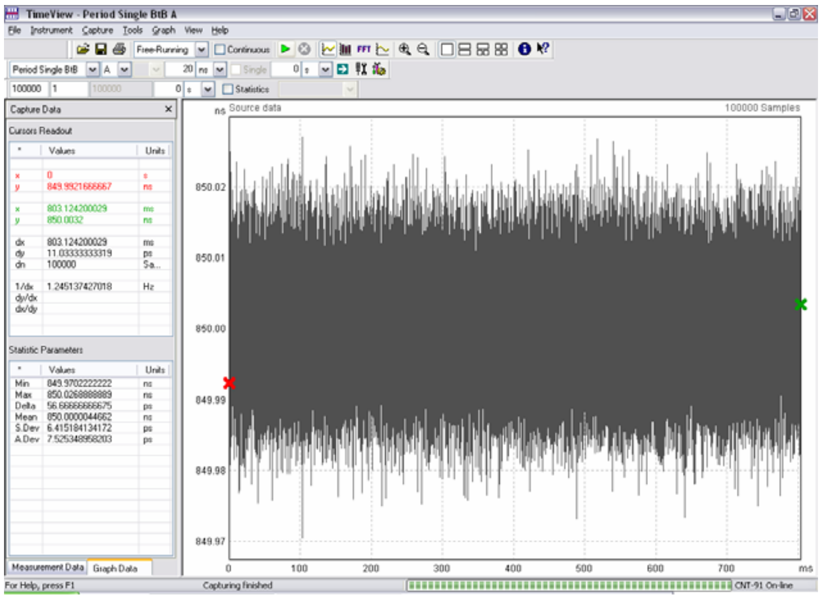


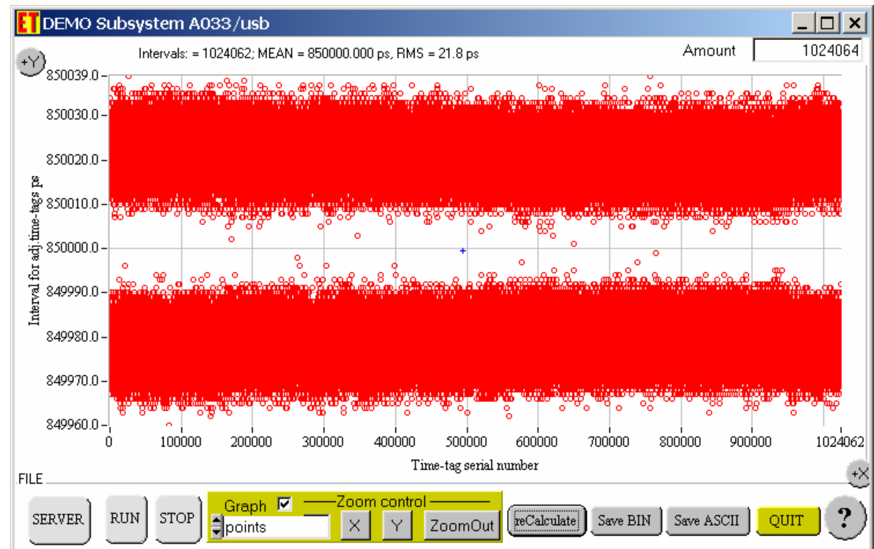
Jitter dependence on time interval for generator T5300U (produced in Poland)

Event Timing System applications (signal modulation analysis)

Comparison results for signal analysis by CNT-91 and A033-ET/usb

Analyzed signal from AFG3251: Freq = 1.17647058825 MHz or back-to-back period 850 ns



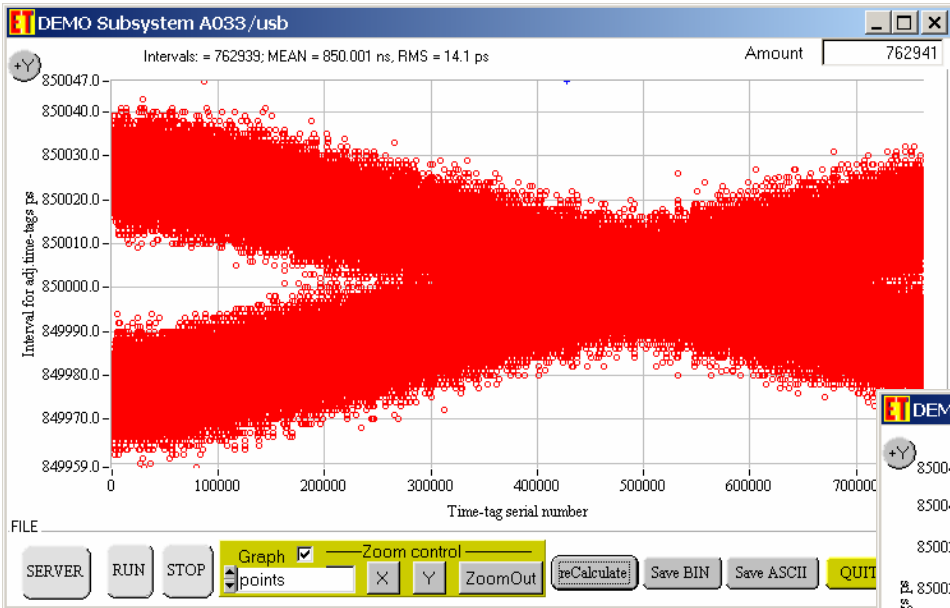


CNT-91 has dead time 8 us; so it takes time-tags of only each 10th pulse of the input signal but counts each pulse and than calculates an averaged period. As result it shows STD = 6.4 ps and estimate is underscored $\sqrt{10}$ times.

A033-ET/usb takes time-tags of all pulses and shows that resultant period 850000.000 ps is derived from two one-by-one generated periods: 850021.427 ps and 849978.573 ps each of them having STD less than 4 ps, but resultant period STD = 21.8 ps and this is the true value.

Event Timing System applications (signal modulation analysis)

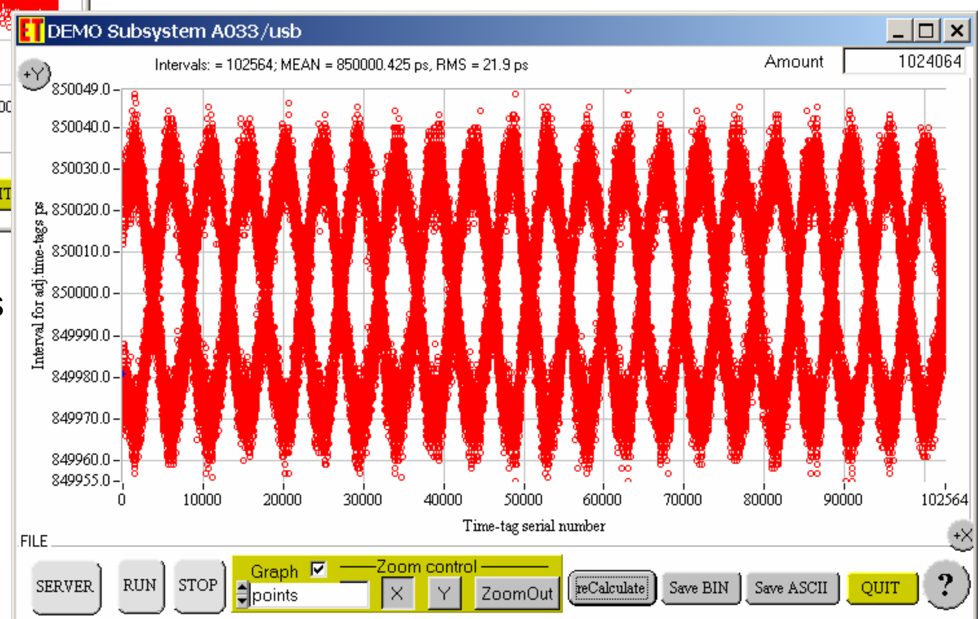
The existence of two periods is defined by using DDS technology (Direct Digital Synthesis) in AFG3251 and physical restriction of its digital capacity. Depending on ratio between clock and synthesized frequency real component periods can be mixed in different ways



Freq = 1.17647059000 MHz

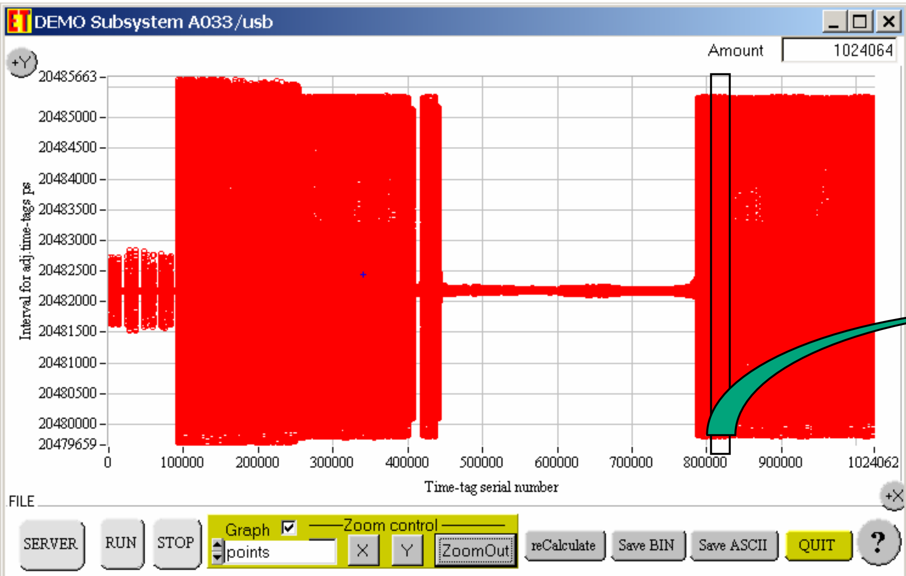
Components periods are changing like sine functions

Freq = 1.17647000000 MHz



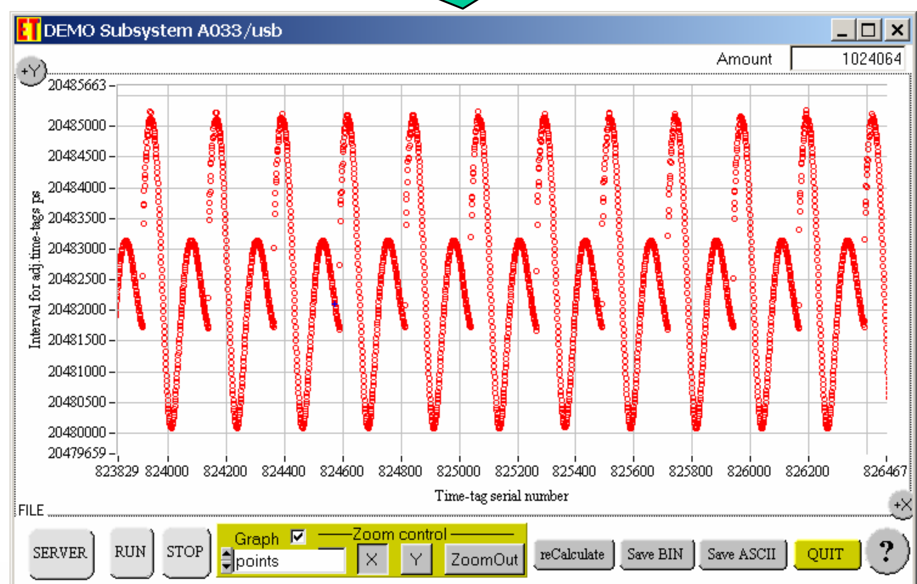
Event Timing System applications (signal modulation analysis)

The study of impact of mobile telephone activity



A033-ET/usb takes time-tags of the signal from the generator with very stable period 20.482 …us (peak-to-peak deviation 26 ps as shown in slide 5). Here we can see an impact of electromagnetic emission from the mobile telephone that is called in GSM 1800 cellular network

zoom in



The measurement by A033-ET/usb shows the modulated signal with periodicity 4.615 ms that corresponds to the GSM frame duration. The handset in GSM 1800 has transmission power only 1 watt, but we can see the period peak-to-peak deviation 5250 ps!

Event Timing System applications (technical systems)

LIDAR and 3-D laser scan systems find distances to surface of the object by timing the round-trip time of a pulse of light.

The main requirements are:

- measurement resolution: +/- 2 mm
- measurement rate: more than 100 KSPS

New Event Timers A033-ET/usb provides:

- measurement resolution: better than 1 mm RMS and
- measurement rate: more than 1 MSPS

and can be successfully used for these tasks.

Rezultāti

Izstrādāta pilot-iekārta:
A033-ET/usb

Izstrādātas programmatūras:
Programma A033usbServer
Programma A033usbClient

Sagatavots dokuments:
Event Timer A033-ET/usb Manual, Institute of Electronics and Computer Science, Riga, Latvia, 2014, 26 p.

Sagatavots raksts starptautiskajai konferencei BEC 2014:
V. Bes'palko, E. Boole, V. Vedin. Precise event timing realisation and its application for signal analysing

Komunikācijas sistēmas prototipa aprobācija reāliem apstākļiem bezvadu datu apmaiņai starp kustīgiem objektiem un attālinātiem serveriem

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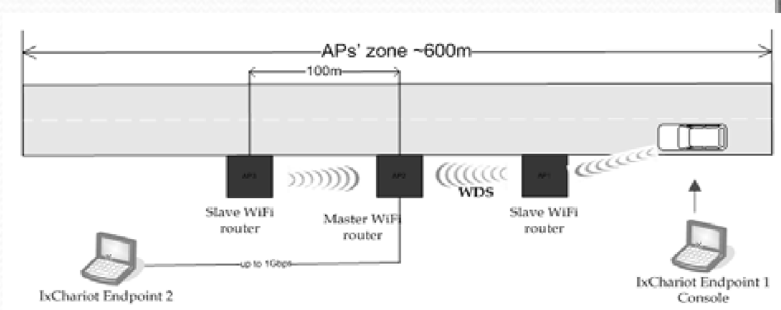
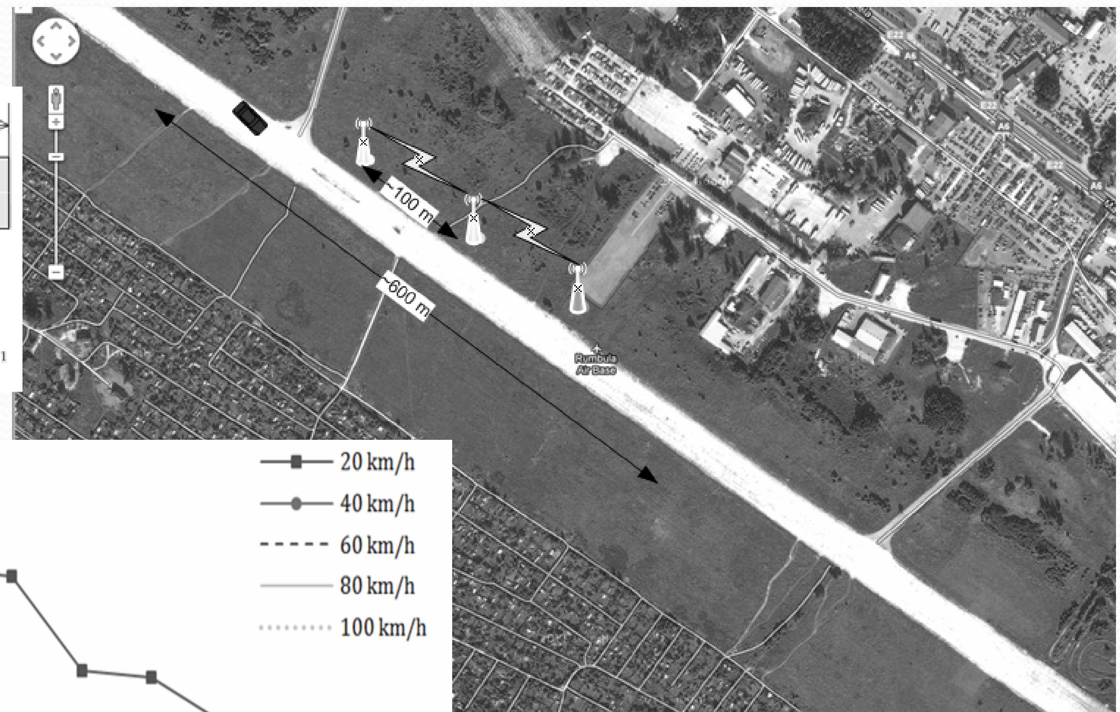
The description of the object

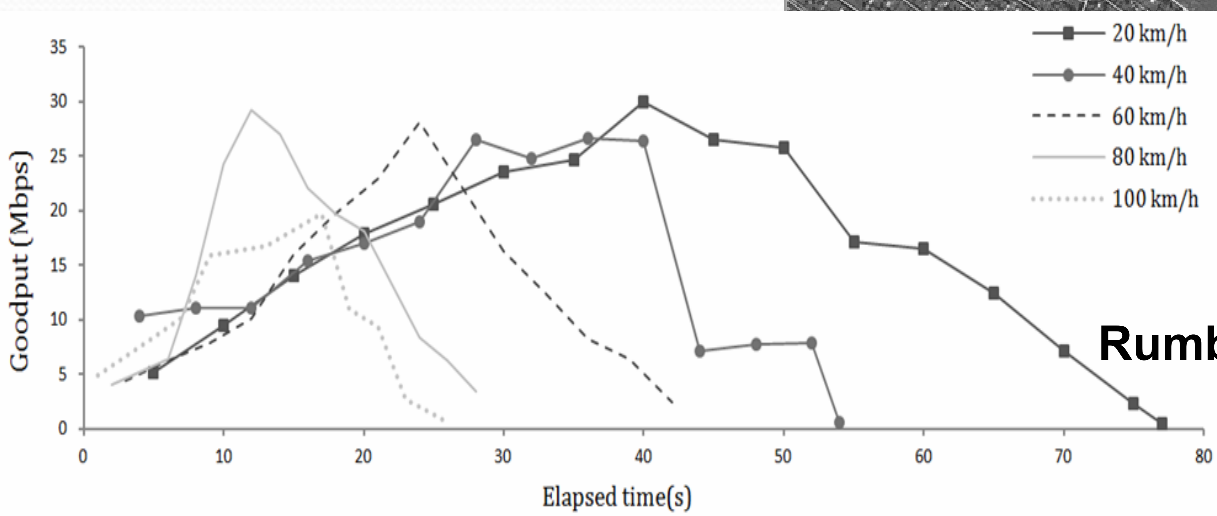
We was calculated a goodput of standards IEEE802.11n and 3G, LTE for open network systems. The physical sphere for the transmission is the wireless network. At the first stage the data is transmitted from the mobile object to the nearest Access Point along the protocol 802.11n. However, the distance from the AP object should not exceed 200 meters. Further from the AP the data is transmitted to the remote base station on the protocol 3G and LTE.

Experiment of 3G, LTE and IEEE802.11n for vehicle

On the picture are depicted the set up of three APs locations in a distance of 100 meters to each other. Only 600 meters long test-bed was used to make the experiment.

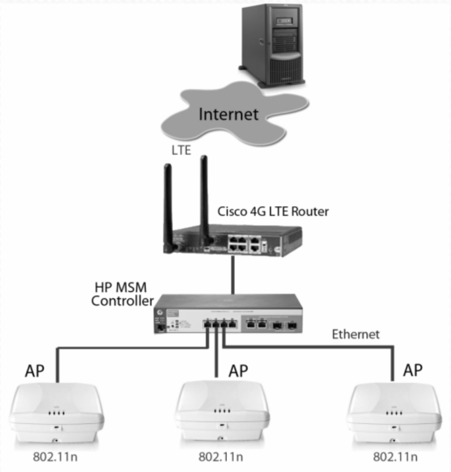


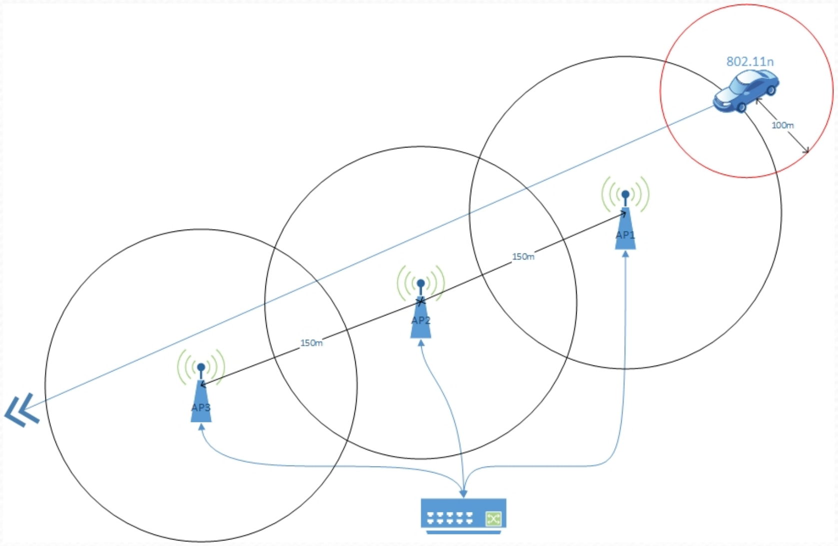




Rumbula, Riga, research polygon

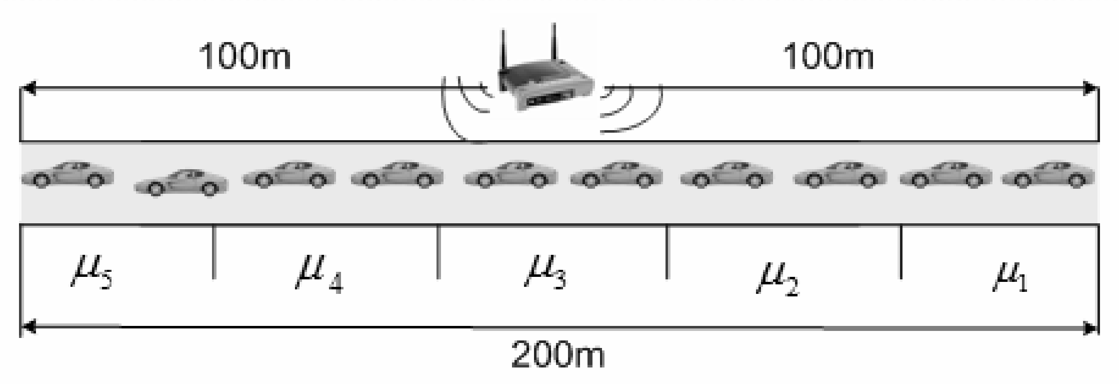
Experiment of 3G, LTE and IEEE802.11n for vehicle





Closed Cyclic estimation model for vehicular number

Following the obtained practical results we will calculate the base station performance at variable client count. In our case the 200 meters long base station operational zone of is divided to 5 zones, 40 meters each, the third zone being the most adjacent to the base station.



200 meter segment consisting of 5 zones, 40 meters each,

Closed Cyclic estimation model for vehicular number

In fact, to determine how to grow the speed of vehicle was made an experiment, as show Figure that velocity grows exponentially:

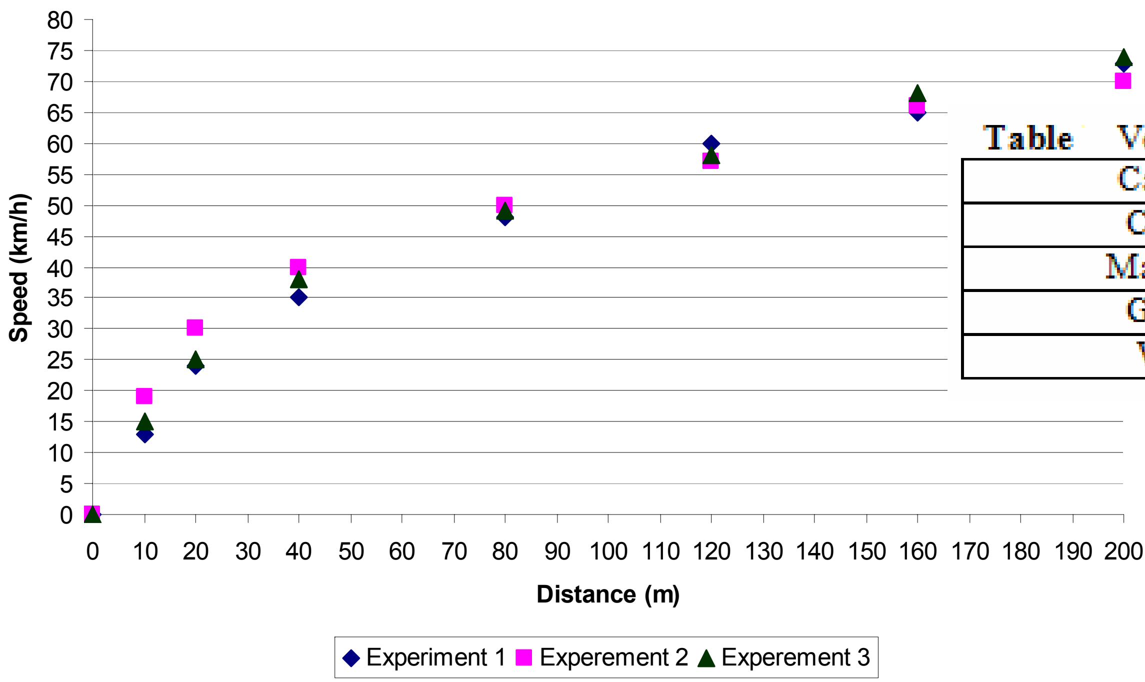


Table Vehicle data

Car brand	VW PASSAT
Capacity	1.8 litre
Max power	90 PS (66kW)
Gearbox	5 speed manual
Weight	1600 kg

The Table shows the technical data of the car which was used in the experiment. The speed grow can be depending on the vehicle data.

Closed Cyclic estimation model for vehicular number

Closed network consisting of M independent nodes with N incoming queries. Distribution is exponential with the parameter ϖ_i .

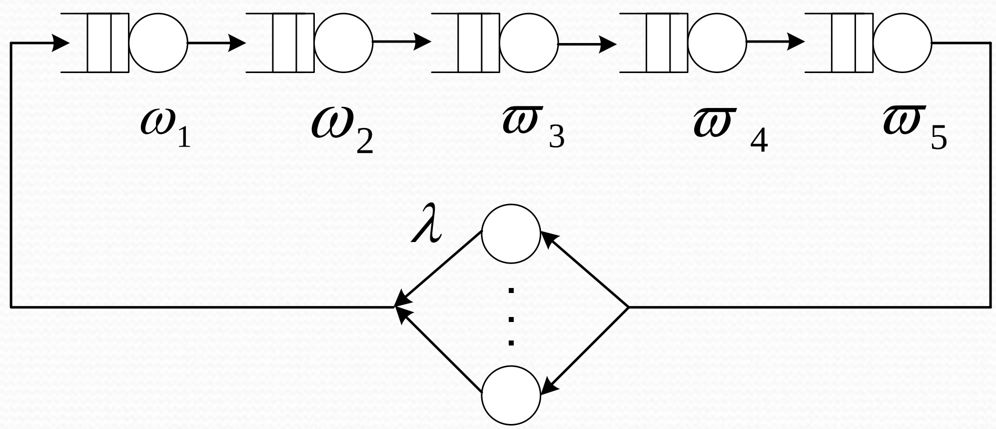
If the interval length equals S_i , and vehicle movement speed equals ϑ_i , then the intensity of vehicle service by road interval equals:

$$\varpi_i = \frac{\vartheta_i}{S_i}$$

Zone number i	1	2	3	4	5
Distance (m)	40	80	120	160	200
Velocity ϑ_i (km/h)	38	49	59	67	74
Intensity μ_i	0.264	0.34	0.41	0.465	0.514

Closed Cyclic estimation model for vehicular number

Such a system can be described in a form of a closed cyclic mass service system network with M service devices, N queries and exponentially distributed service time. Query service intensity in the i-th interval equals ϖ_i , as show in Figure.:



Closed cyclic system

Closed Cyclic estimation model for vehicular number

Due to the periodic nature of this model $x_1 = 1$

and the next step is calculated as follows: $x_2 = \dfrac{\omega_1}{\omega_2}, x_3 = \dfrac{\omega_1}{\omega_3}, \ldots, x_M = \dfrac{\omega_1}{\omega_M}$

Buzen's algorithm the most effective methods for closed network analysis, as show in Table. Buzen's matrix, at the row i and column j can be calculated using the formula:

$$g(i, j) = g(i, j-1) + g(i-1, j)xj$$

Table Buzen's matrix

Nr.	1	0.62	0.5	0.45	0.43
0	1	1	1	1	1
…	…	…	…	…	…
9	1	2,6357	5,298	9,6113	16,5219
10	1	2,6447	5,3414	9,753	16,9069
…	…	…	…	…	…
19	1	2,65944	5,4159	10,0096	17,6447
20	1	2,65949	5,4162	10,0106	17,6508

$$\frac{G(N-1)}{G(N)}$$

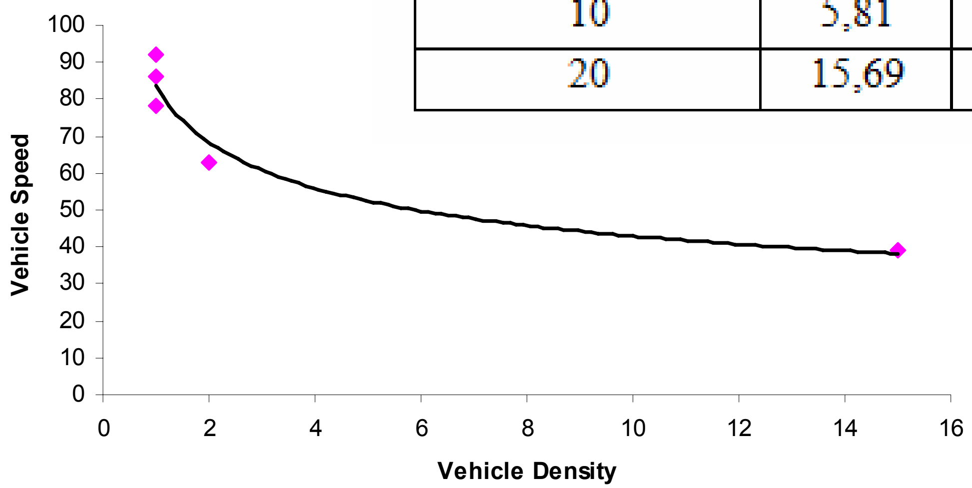
Vehicular number

Average number of moving vehicles, competing for resources of base station is calculated in this manner:

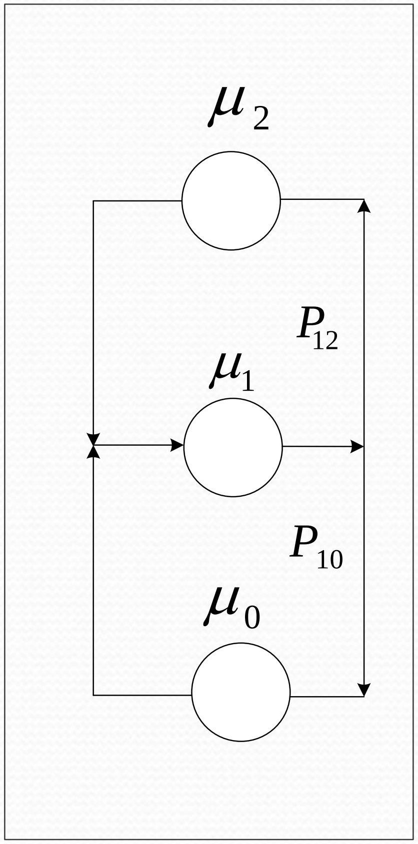
$$E(n_i) = \sum_{k=1}^{N} \left[x_i^k \cdot \frac{G(N-k)}{G(N)} - x_i^{k+1} \cdot \frac{G(N-k-1)}{G(N)} \right]$$

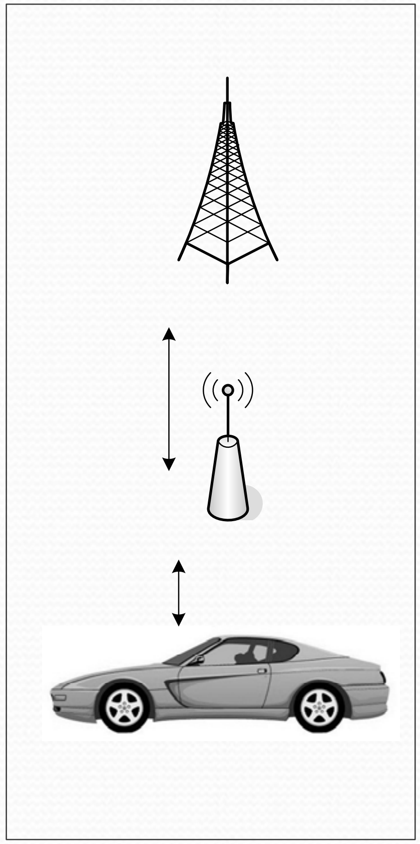
TABLE AVERAGE NUMBER OF QUERIES

Vehicle (N)	*Zone 1*	*Zone 2*	*Zone 3*	*Zone 4*	*Zone 5*
10	5,81	1,03	0,92	0,76	0,69
20	15,69	1,65	1,04	0,85	0,76



Two Layer Model





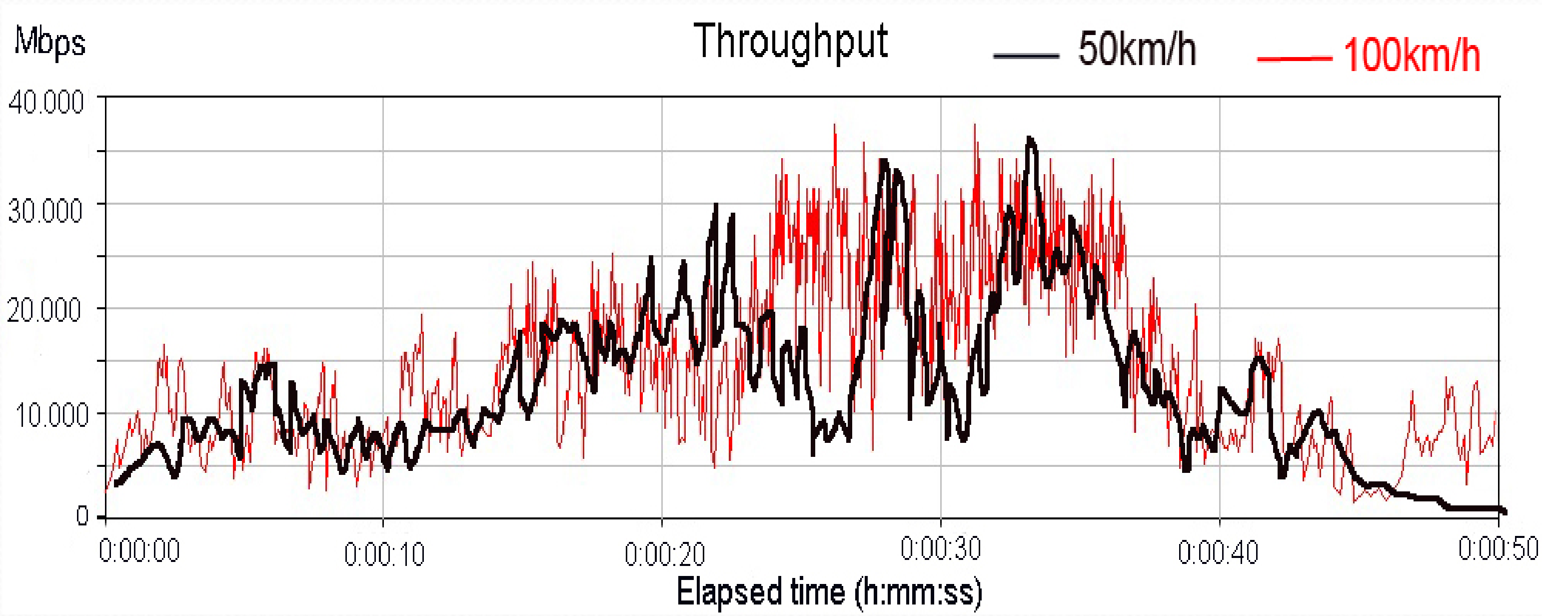
The terminal count in each vehicular wireless network is usually high.
Bandwidth equation for a two layer network:

$$X_1 = \frac{\mu_0}{\mu_1 P_{10}}; \qquad X_2 = aX_1 \qquad a = \frac{\mu_1}{\mu_2} P_{12}$$

Two Layer Model

There μ_1 for i-th region is obtained from measurement results, illustrated in Figure.

$$\mu_1 = \beta_i$$



Two Layer Model

The average time for the transmission will be varying: more time is spending on the transmission of the data packets, which we denote as $E(t_i)$.

The ACK transmission takes less time denotes it as $E(t_0)$

Then the average time of the data processing in the first node will be:

$$E(t_1) = \frac{E(t_i) + E(t_0)}{2}$$

If on the top of each transmitted packet we receive the ACK confirmations. In this case the intensity of the processing in the first node will be:

$$\mu_0 = \frac{1}{E(t_1)}$$

Two Layer Model

The intensity for the μ_2 :

$$\mu_2 = \frac{1}{t} \qquad t = \frac{l_p}{V_f}$$

Where V_f - effective data transfer rate for the IEEE802.16e protocol.

For the data transmission between the Access Point and the base station is used IEEE802.16e protocol, this protocol will have the peak transfer rate V_n = 50Mbps.

The packet length will be $l_p = 1500 bytes$, but the actual speed is determined in the following way:

$$V_f = \frac{V_n}{2}$$

Two Layer Model

$$G(N)=\sum_{\bar{n}}\prod_{i=1}^{3}\left(X_i\right)^n i,$$

Where N - number of vehicles. Function for the studied two layer vehicular network looks like this:

$$G(N)=\frac{1}{1-a}\sum_{j=0}^{N}X_1^j\left(1-a^{j+1}\right).$$

Goodput η of the two layered network is defined as the count of processed inquiries in a unit of time. The finished task is put out trough the subsystem of input/output, and instantly trough it a new task is loaded. Probability of a lack of inquiries in i-th node:

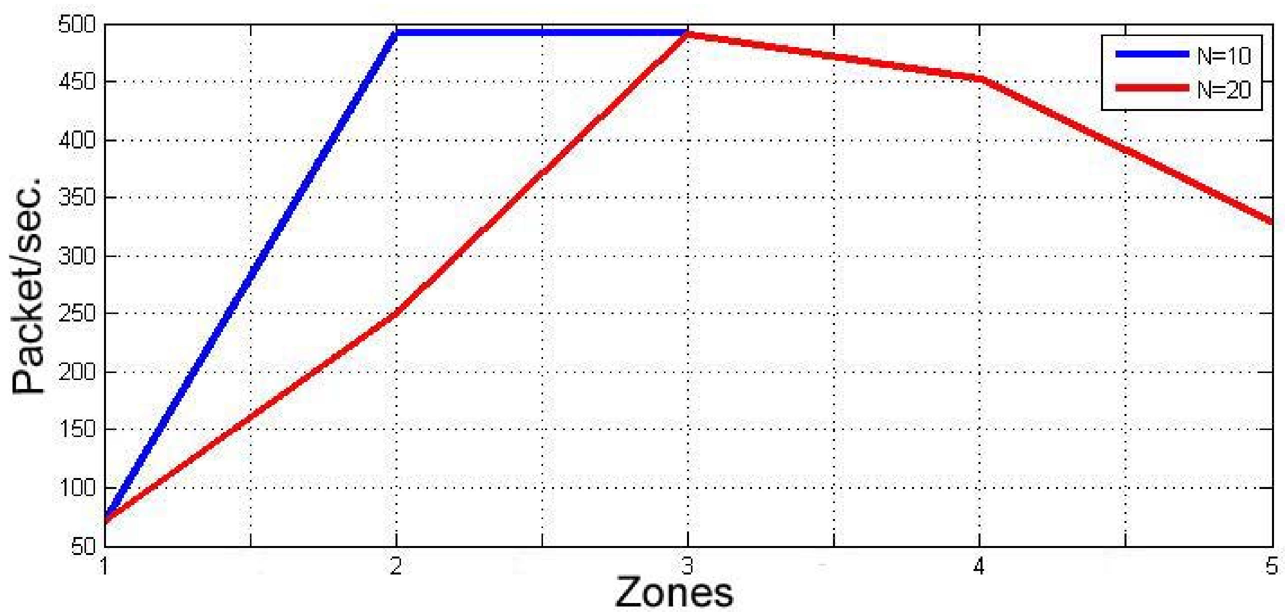
$$p\{n_i=0\}=\frac{G(N)-X_iG(N-1)}{G(N)}$$

The output flow is equal to input flow and from this rule of flow balance it is possible to write:

$$\eta=P_{10}\mu_1(1-p\{n_i=0\})$$

Two Layer Model

Goodput with the probability P10=0.999 P12=0.001 for N=10 and N=20 will be:



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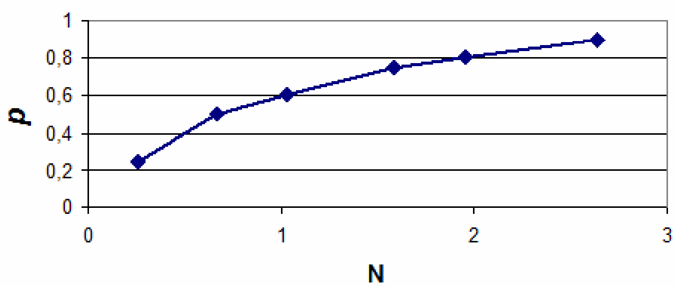
Erlang Distribution for Vehicle

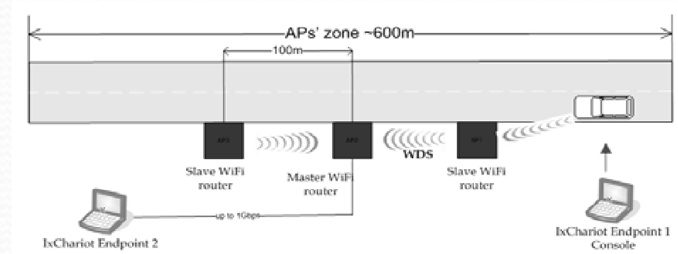
$$L = \frac{\rho}{1 - r_0^k}$$

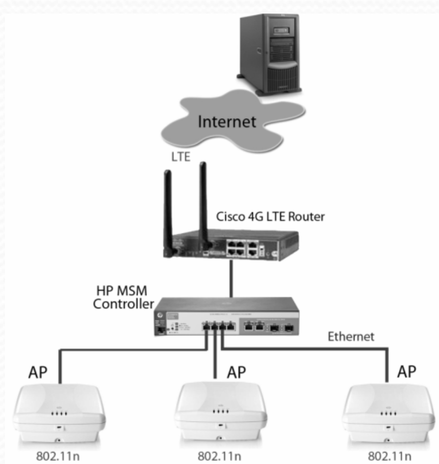
$$q_z \cdot r^{k+1} - (k \cdot \lambda_2 + q_z) r + k\lambda_2 = 0$$

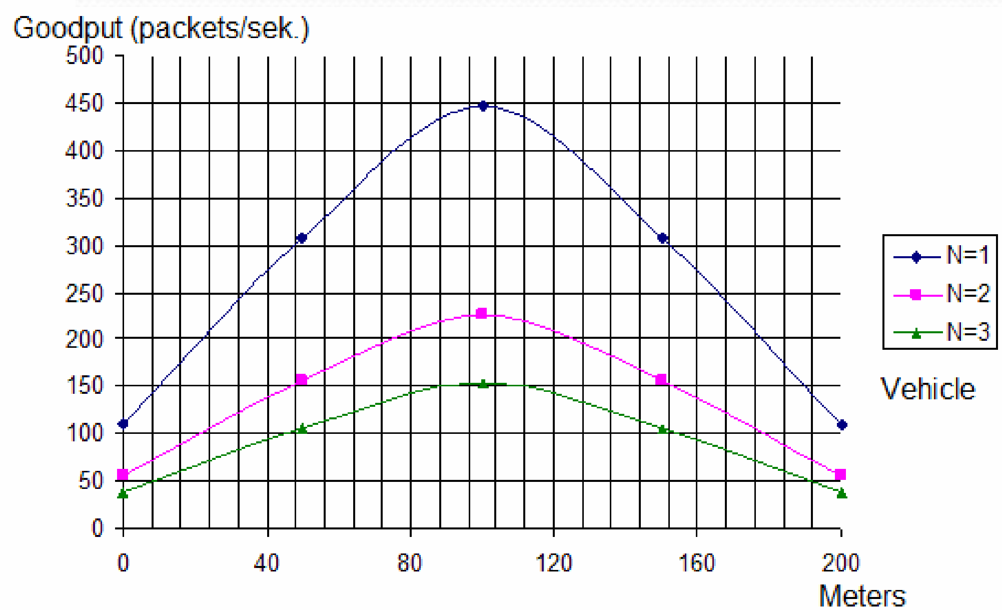
к=5

ρ	0,25	0,5	0,6	0,75	0,8	0,9
r_0	0.56	0.76	0.84	0.88	0.9	0.92
$L = N$	0.265	0.67	1.031	1.588	1.954	2.64





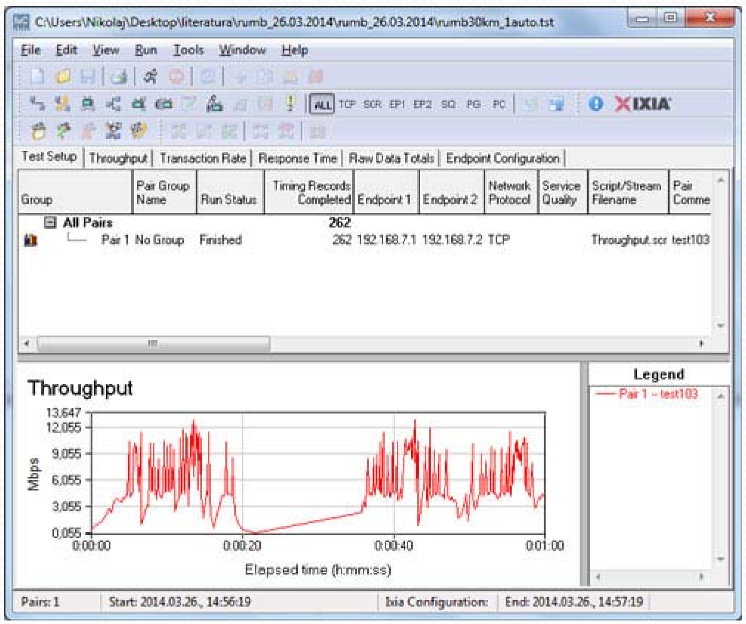


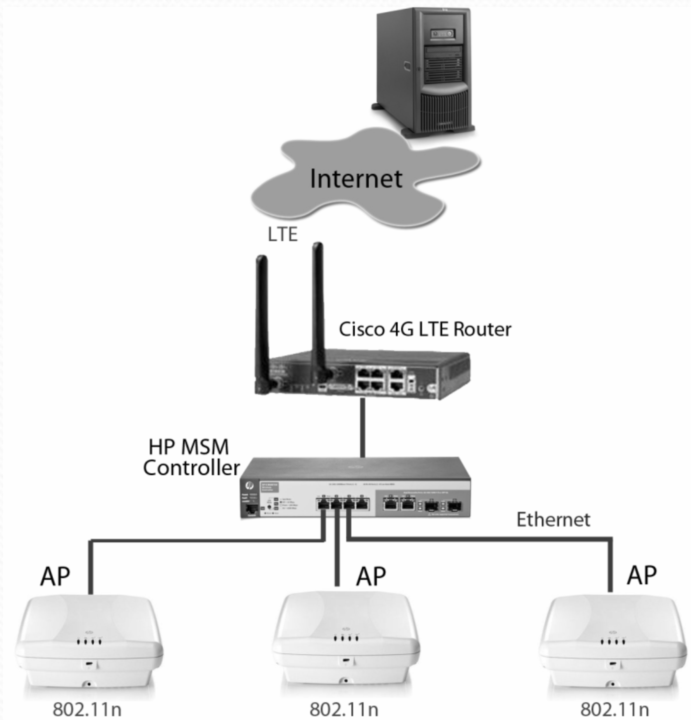


EXPERIMENTAL ESTIMATION OF VEHICULAR NETWORK

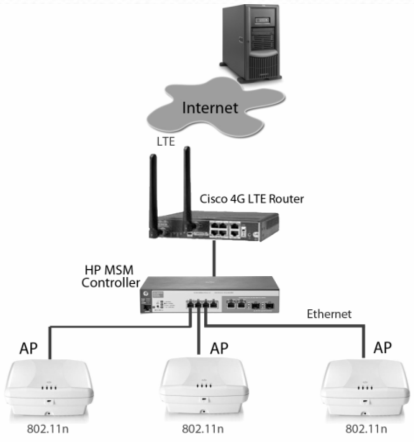
The estimation was made by the means of IxChariot software. The main feature is the fact of speed measurement of the data transmission depending on the remoteness of the mobile object from the base station and its moving speed.

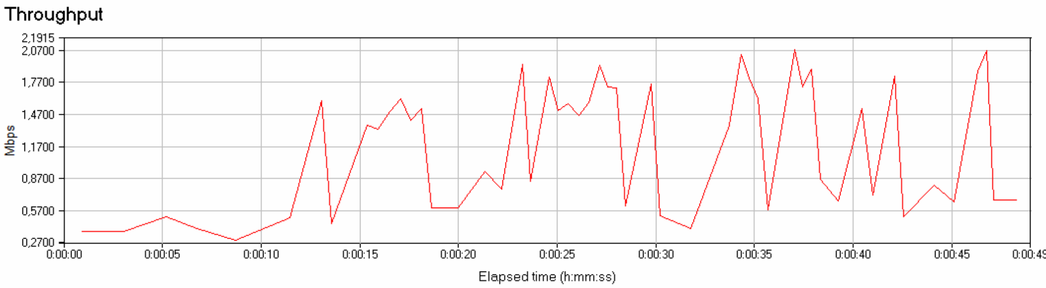
Scheme “test-bed” is presented below :



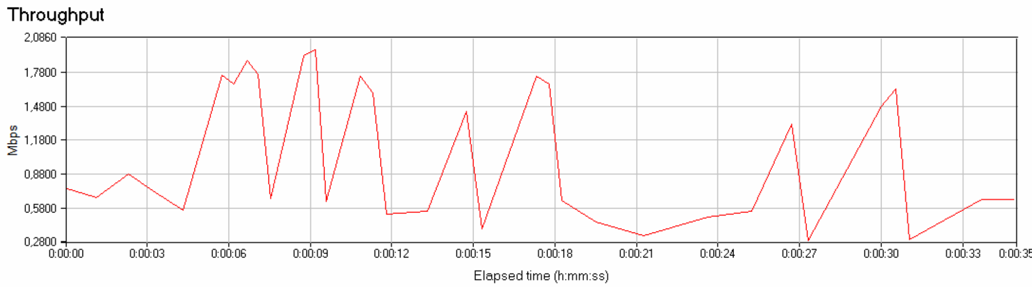


One channel provides data transfer in GPRS mode. The second channel, being characterized by a high data transfer rate, uses LTE mode – the mode of the next generation of mobile communications

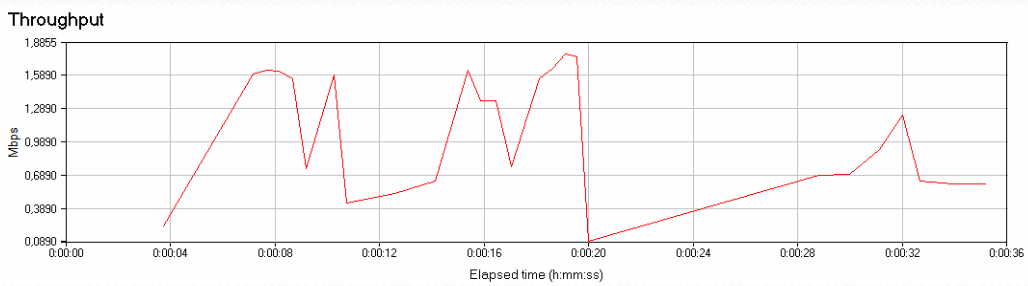




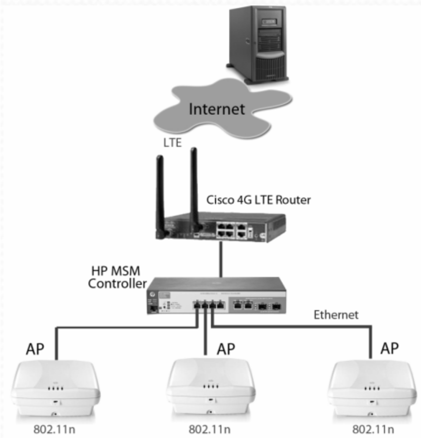
Two stage goodput with 3G and 802.11n at speeds of 20km/h

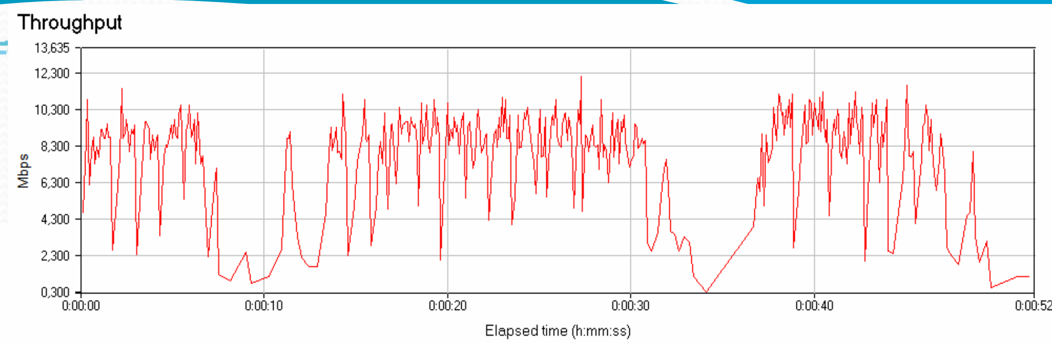


Two stage goodput with 3G and 802.11n at speeds of 40km/h

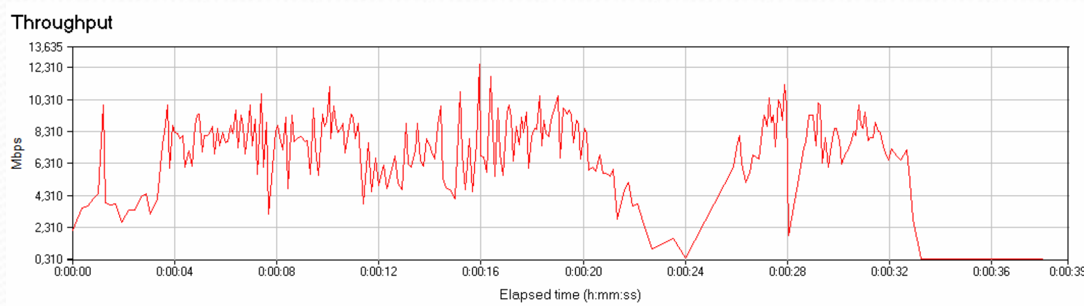


Two stage goodput with 3G and 802.11n at speeds of 90km/h

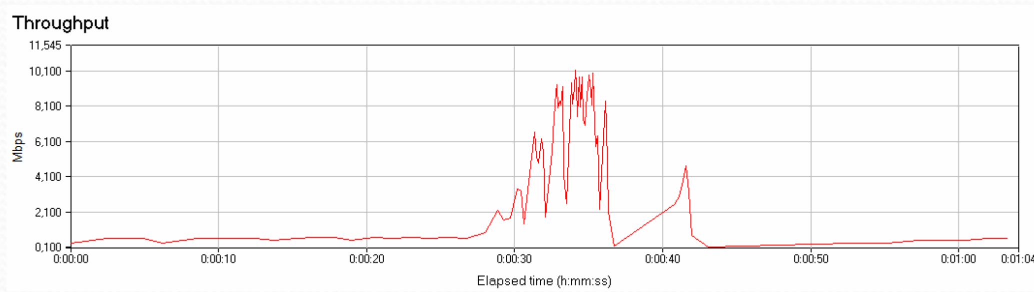




Goodput graph for the client travel speed of 20 km/h along the access points



Goodput graph for the client at the travel speed of 50 km/h along the access points



Goodput graph for the client at the travel speed of 90 km/h along the access points

Publications: The following papers, related with promotion research have been published:

1. Pētersons E., Bogdanovs N. Performance Evaluation of Three Layer Vehicular Network // Electronics and Electrical Engineering. - 6. (2011) pp 25-28.
2. Bogdanovs N., Ipatovs A., Jansons J. Research of a 2-layer Closed Vehicular Network // Scientific Journal of RTU. 7. series., Telekomunikācijas un elektronika. - 11. vol. (2011), pp 34-40.
3. Bogdanovs N., Jansons J., Ipatovs A. Parameter Estimation for Model of Vehicular Network // 52nd International Scientific Conference of Riga Technical University, Latvija, Riga, 13.-14. oktobris, 2011. - 1.-26. lpp
4. Jansons J., Pētersons E., Bogdanovs N. Vehicle-To-Infrastructure Communication Based on 802.11n Wireless Local Area Network Technology // 2nd Baltic Congress on Future Internet Communications (BCFIC 2012): IEEE Conference Proceedings: IEEE Xplore Digital Library, **Lithuania**, Vilnius, 25.-27. April, 2012. - pp 26-31.
5. Jansons J., Pētersons E., Bogdanovs N. IEEE802.11n Standard's Capability to Support Wireless Device in Vehicular Environment // Electrical and Control Technologies (ECT-2012): The 7th International Conference , Lithuania, Kaunas, 3.-4. May, 2012. - pp 44-47.
6. Ipatovs A., Bogdanovs N., Pētersons E. Evaluation of the Rate of the Data Transfer between Vehicles and Base Stations in Wireless Networks // Automatic Control and Computer Sciences. - Vol.46, Iss.2. (2012) pp 76-82.
7. Ipatovs A., Pētersons E., Bogdanovs N. Evaluation of the Rate of the Data Transfer between Vehicles and Base Stations in Wireless Networks // Автоматика и вычислительная техника. - 2. (2012) pp 31-41.
8. Bogdanovs N., Pētersons E., Jansons J. Modeling Results of Vehicular Network for File Transfer // The 7th International Conference on Electrical and Control Technologies, Lithuania, Kaunas, 3.-4. May, 2012. - pp 60-63.
9. Pētersons E., Bogdanovs N. Bandwidth Calculation of Short Range Communication Vehicular Network // International Conference of Young Scientists on Energy Issues (CYSENI 2012), Lithuania, Kaunas, 24.-25. May, 2012. - pp III-145-III-151.
10. Jansons J., Bogdanovs N., Ipatovs A. Vehicle-to-Infrastructure Communication Based on IEEE 802.11g // International Journal of Digital Information and Wireless Communications. - Vol.2, No.1. (2012) pp 858-862.
11. Jansons, J., Doriņš, T., Bogdanovs, N. Analyzing the Basic Performance of IEEE802.11g/n. International Journal on New Computer Architectures and Their Applications, 2012, Vol.2, No.3, pp.465-470. ISSN 2220-9085

12. Jansons, J., Barancevs, A., Pētersons, E., Bogdanovs, N. IEEE802.11a Standard Performance in Mobile Environment. International Journal on New Computer Architectures and Their Applications, 2012, Vol.2, No.3, pp.497-500. ISSN 2220-9085.
13. Jansons J., Pētersons E., Bogdanovs N. A Measurement Study of WLAN Link Recovery Using WDS in a Vehicular Environment // Proceedings of the 13th Biennial Baltic Electronics Conference (BEC2012), **Estonia**, Tallinn, 3.-5. October, 2012. - pp 173-174.
14. Bogdanovs N., Pētersons E., Šarkovskis S. Modelling of Vehicular Network for Short Range // Proceedings of the 12th International Conference „Reliability and Statistics in Transportation and Communication" (RelStat-12), **Latvia**, Riga, 17.-20. October, 2012. - pp 195-203.
15. Jansons, J., Pētersons, E., Bogdanovs, N. Analyses and Evaluation of Wireless Local Area Network in Vehicular Mobility Scenarios. Electronics and Electrical Engineering, 2013, Vol.Vol.19, No.2, pp.97.-100. e-ISSN 20295731. ISSN 13921215. Available from: doi:10.5755/j01.eee.19.2.3477
16. Bogdanovs, N., Pētersons, E., Jansons, J. Two Layer Model for Performance Evolution of V2I Network. Electronics and Electrical Engineering, 2013, Vol.19, No.3, pp.98-101. ISSN 1392-1215. Available from: doi:10.5755/j01.eee.19.3.3704
17. Jansons, J., Pētersons, E., Bogdanovs, N. WiFi for Vehicular Communication Systems. In: 27th International Conference on Advanced Information Networking and Applications Workshops: 27th IEEE AINA 2013, **Spain**, Barselona, 25-28 March, 2013. Fukuoka: 2013, pp.425-430. ISBN 9780769549521.
18. Bogdanovs, N., Pētersons, E., Jansons, J. Simulation to Evaluate Performance of Two Layer Vehicular Networks. In: The International Conference on Technological Advances in Electrical, Electronics and Computer Engineering (TAEECE2013), **Turkey**, Konya, 9-11 May, 2013. Konya: Mevlana University, 2013, pp.548-553. ISBN 9781467356114.

Conclusions

In this research experimental data is presented, about data transfer rate in wireless networks of IEEE 802.11n standard connecting moving objects. Based on the experimental data mathematical patterns were developed binding characteristics of vehicular flow with characteristics of data transfer system. Experimental data is presented in this research, concerning data transfer rate in IEEE 802.11n standard wireless network of moving objects. Based on experimental data two mathematical models were developed, binding the characteristics of vehicular flow and characteristics of data transfer system.

In the presented research, a model for real data transfer rate estimation depending from number N of moving objects located in the wireless network base stations operational zone was developed. Based on this research, the real data transfer rate depends from the number and distances from base station of objects interacting with base station.

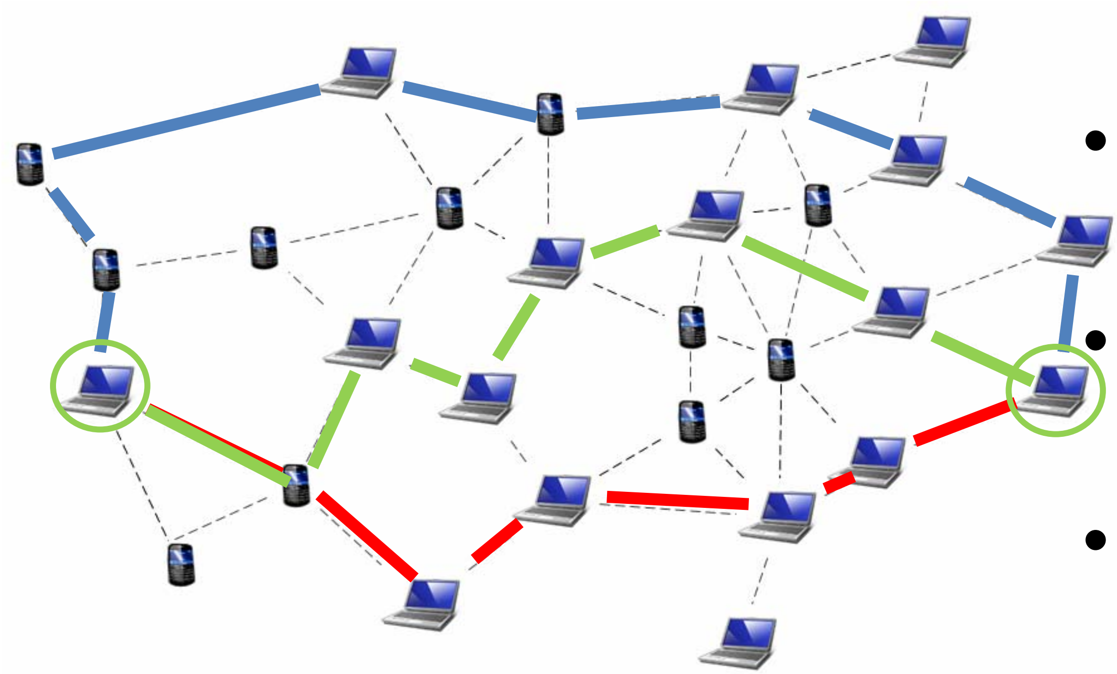
Thank you for attention!

Metode vairāku maršrutu pārraides efektivitātes novērtēšanai kognitīvos ad-hoc tīklos pie dažādiem radioviļņu izplatīšanās modeļiem

Lauris Cikovskis, Ilmārs Slaidiņš

RTU, Radioiekārtu katedra

Ievads



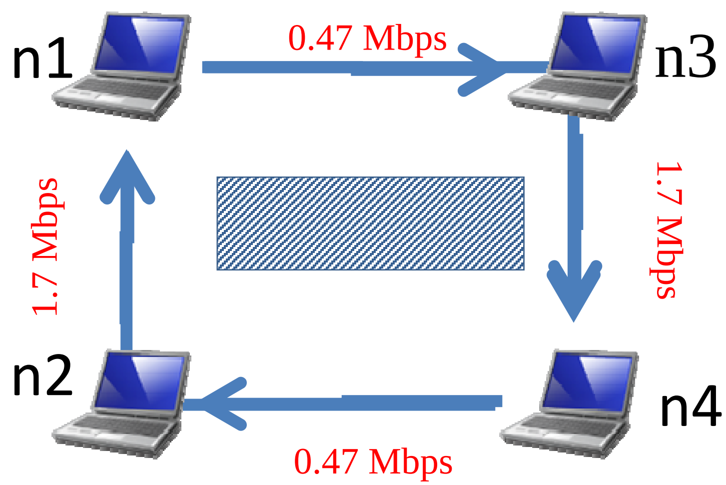
- Daudz-lēcienu maršrutēšana
- Viens maršruts
  - Ierobežota caurlaidspēja
- Vairāki maršruti
  - Savstarpēji traucējumi
- Nepieciešamība pēc «gudras» maršrutēšanas

Motivācija un mērķi

- Labāk izprast tīkla uzvedību vairāku maršrutu pārraides apstākļos

- Mērķi
  - pielāgot esošas analītiskas metodes
  - izstrādāt tīkla imitācijas rīku Matlab
  - parādīt starp-maršrutu attāluma ietekmi uz caurlaides spēju
  - pārbaudīt pie dažādiem radio viļņu izplatīšanās modeļiem

Analītiska metode [by S.Toumpis,A.Goldsmith, Jain K.]



- Pārraides shēmas

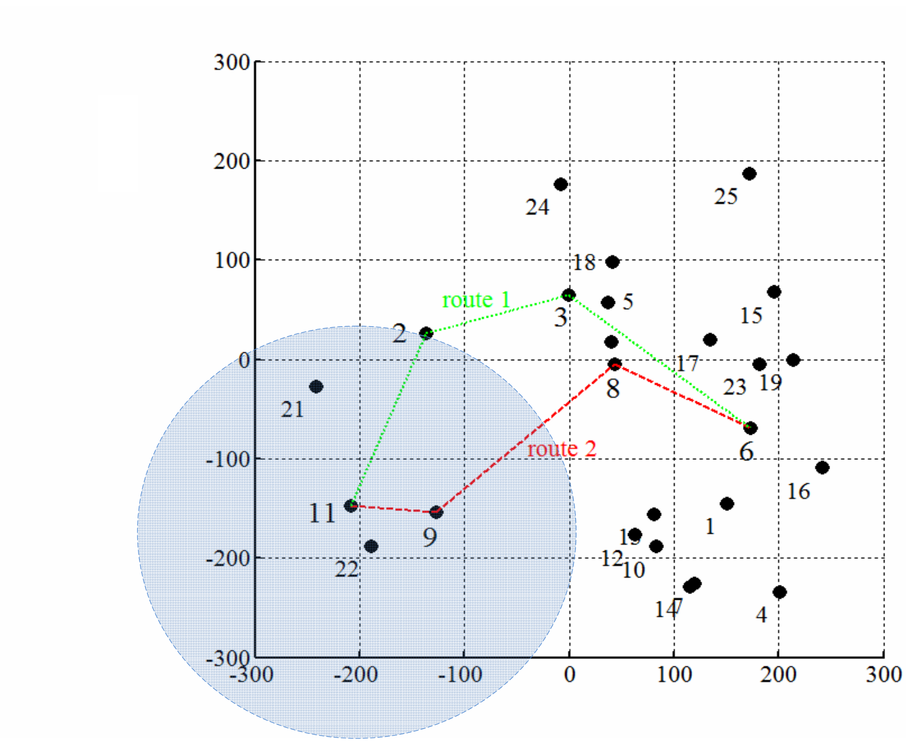
$$0.75 \begin{bmatrix} n\_1 & \rightarrow & n\_3 \\ n\_4 & \rightarrow & n\_2 \end{bmatrix}_{\text{0.47 Mbps}} + 0.25 \begin{bmatrix} n\_3 & \rightarrow & n\_4 \\ n\_2 & \rightarrow & n\_1 \end{bmatrix}_{\text{1.7 Mbps}}$$

- Laika sadalījuma koeficients τ

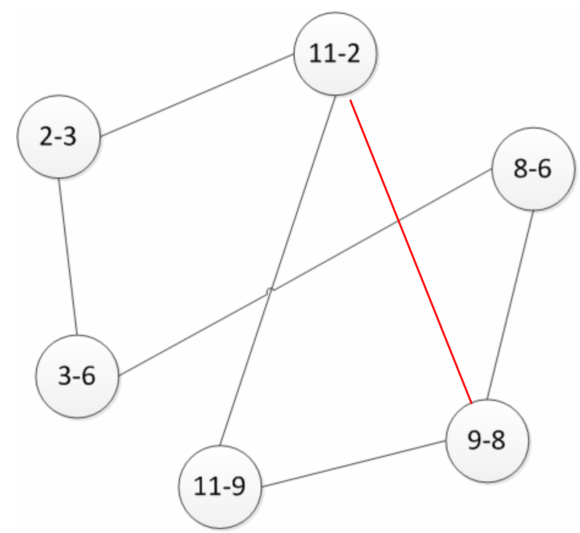
$$0 \le \tau_i \le 1, \sum_{i=1}^{k} \tau_i = 1$$

Pielāgošana vairākiem maršrutiem

Piemērs: 2-maršrutu pārraide (no n_{11} uz n_6)



Visas iespējamās pārraides shēmas				
1	2	3	4	5
2 → 3 8 → 6 11 → 9	8 → 6 11 → 2	3 → 6 9 → 8 11 → 2	3 → 6 11 → 9	2 → 3 9 → 8



- CSMA/CA implementācija
  - Ierobežo vienlaicīgi pieļaujamos savienojumus

Maksimāla kopējā caurlaides spēja

- Atrast optimālu τ kopu (laika plānojumu)
  - maksimāls datu plūsmas ātrums maršrutos kopā

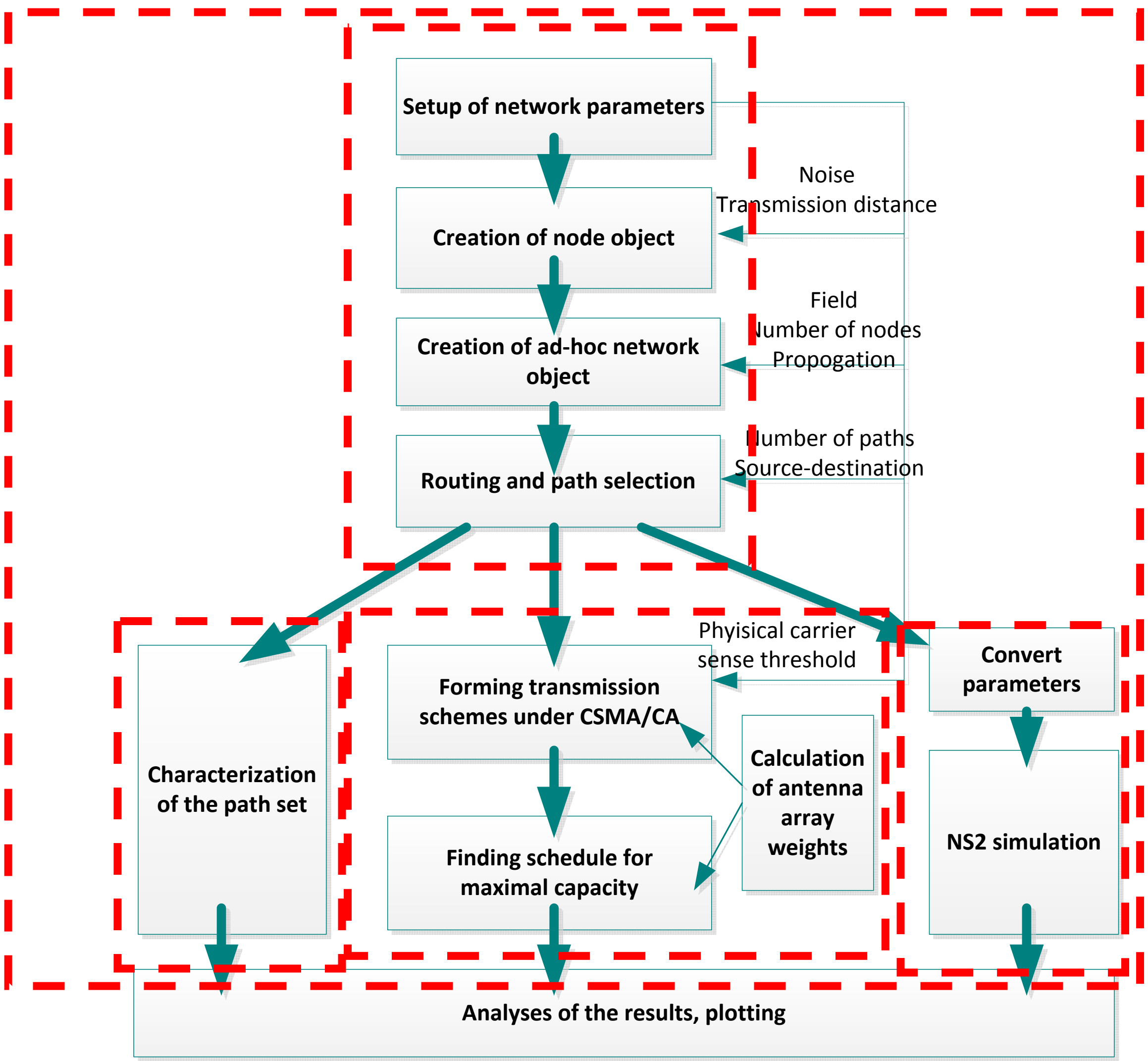
$$max \sum C_{s \to i}$$

  - vienmērīga plūsma maršruta ietvaros

$$C_{link1}^{m} = C_{link2}^{m} = \ldots = C_{linkn}^{m}$$

- rezultāts = labākais gadījums, uz kuru tiekties

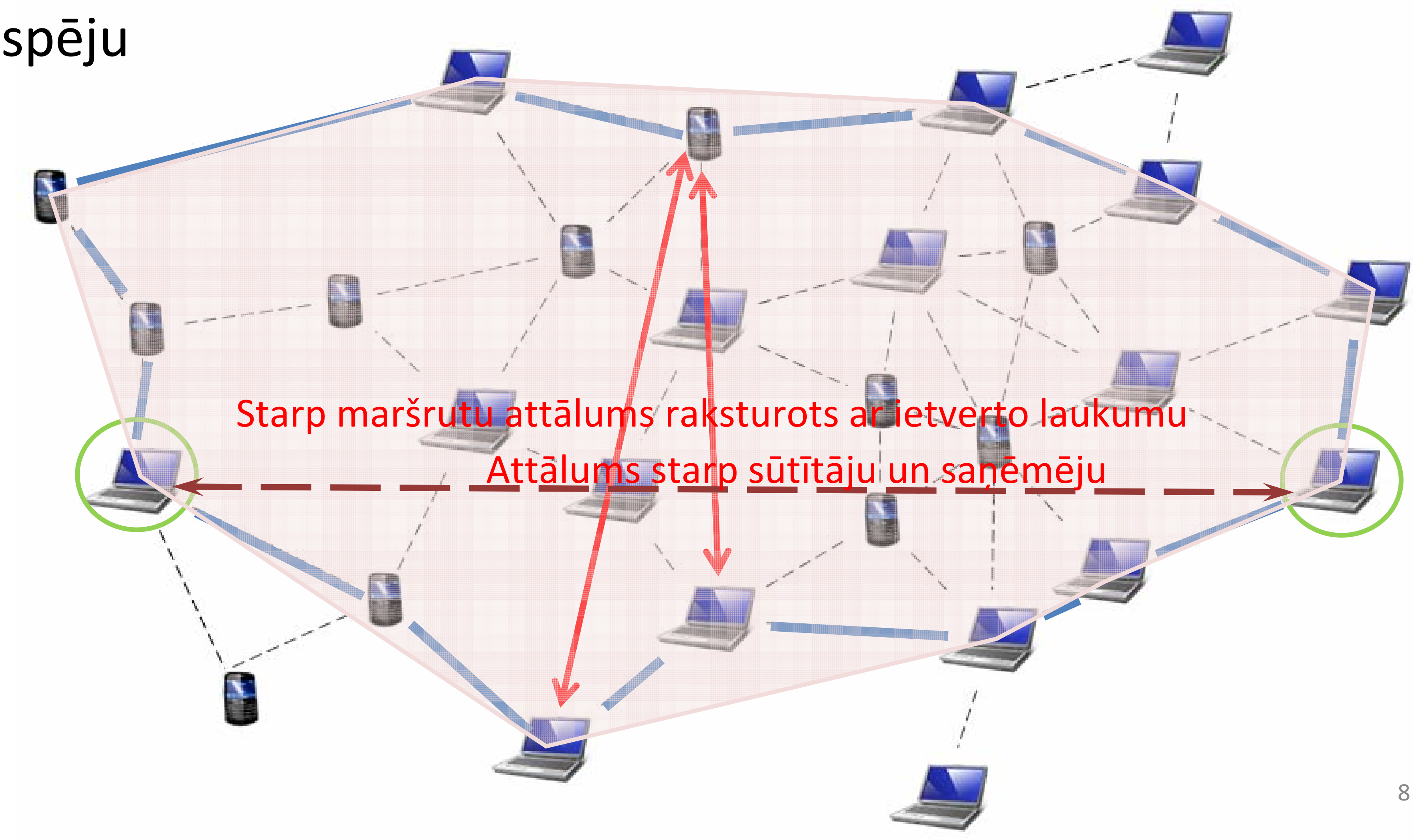
Matlab rīka darbības blokshēma



- Scenārija uzstādīšana
- Maršrutu raksturošana
- Analītisko aprēķinu daļa
- Modeļu pārbaude NS-2
- Aprēķinu uz skaitļošanas klastera (MATLAB DCS)

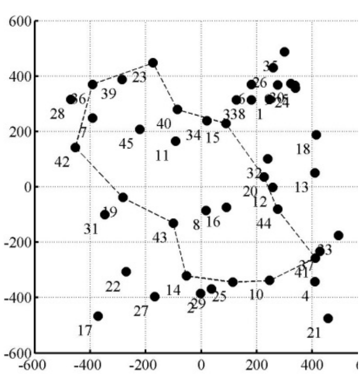
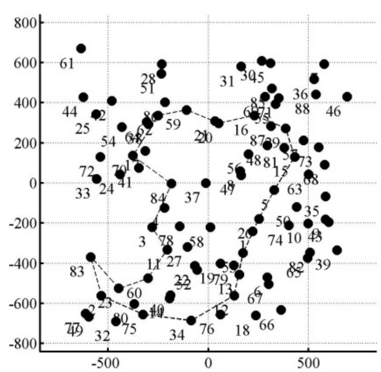
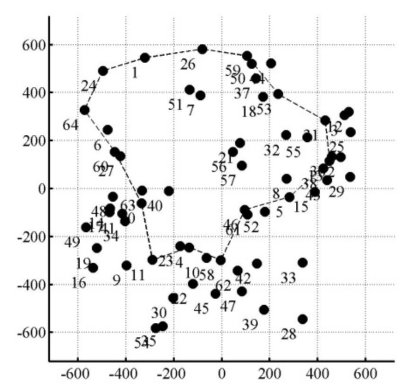
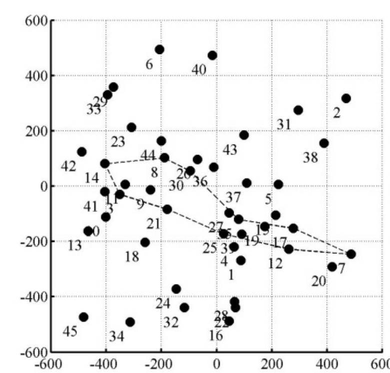
Rīka pielietojums

Pārbaudīt starp maršrutu attāluma ietekmi uz caurlaides spēju



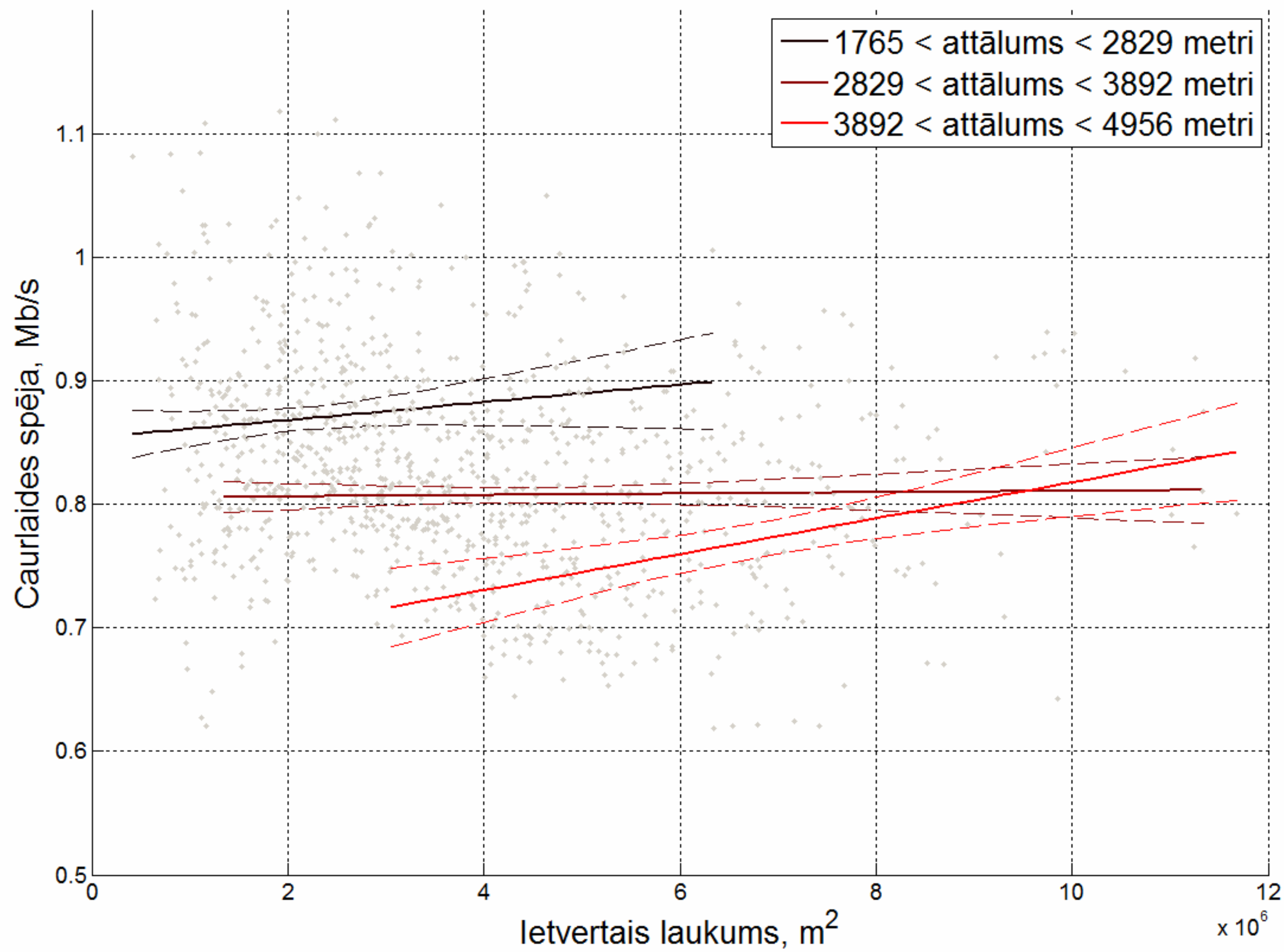
Modelēšanas parametri

Parametrs	Vērtība
Analizēto scenāriju skaits	~1000
Raidīšanas jauda	0.1 W (20 dBm)
Troksnis	$8 \cdot 10^{-14}$ W (-101 dBm)
Radio viļņu izplatīšanās modelis	brīva telpa
Raidīšanas attālums (d)	547 m
Nesēja jušanas attālums	2 × raidīšanas attālums
Nesējfrekvence	2.45 Ghz
Kanāla platums	20 MHz

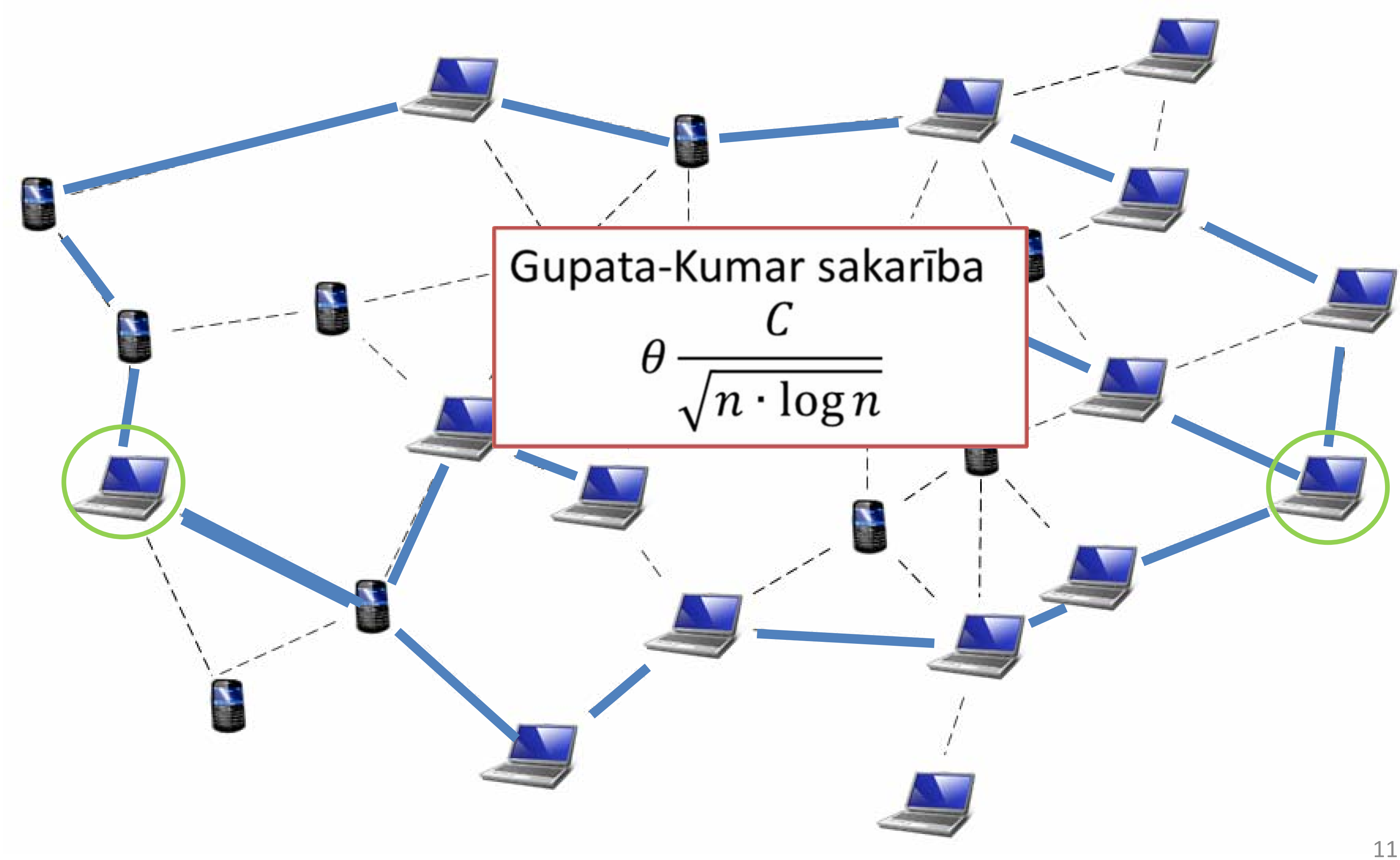





Caurlaides spēja pret attālumu

Brīvas telpas modelis



Caurlaides spējas atkarība no mezglu skaita



Gupata-Kumar sakarība

$$\theta \frac{C}{\sqrt{n \cdot \log n}}$$

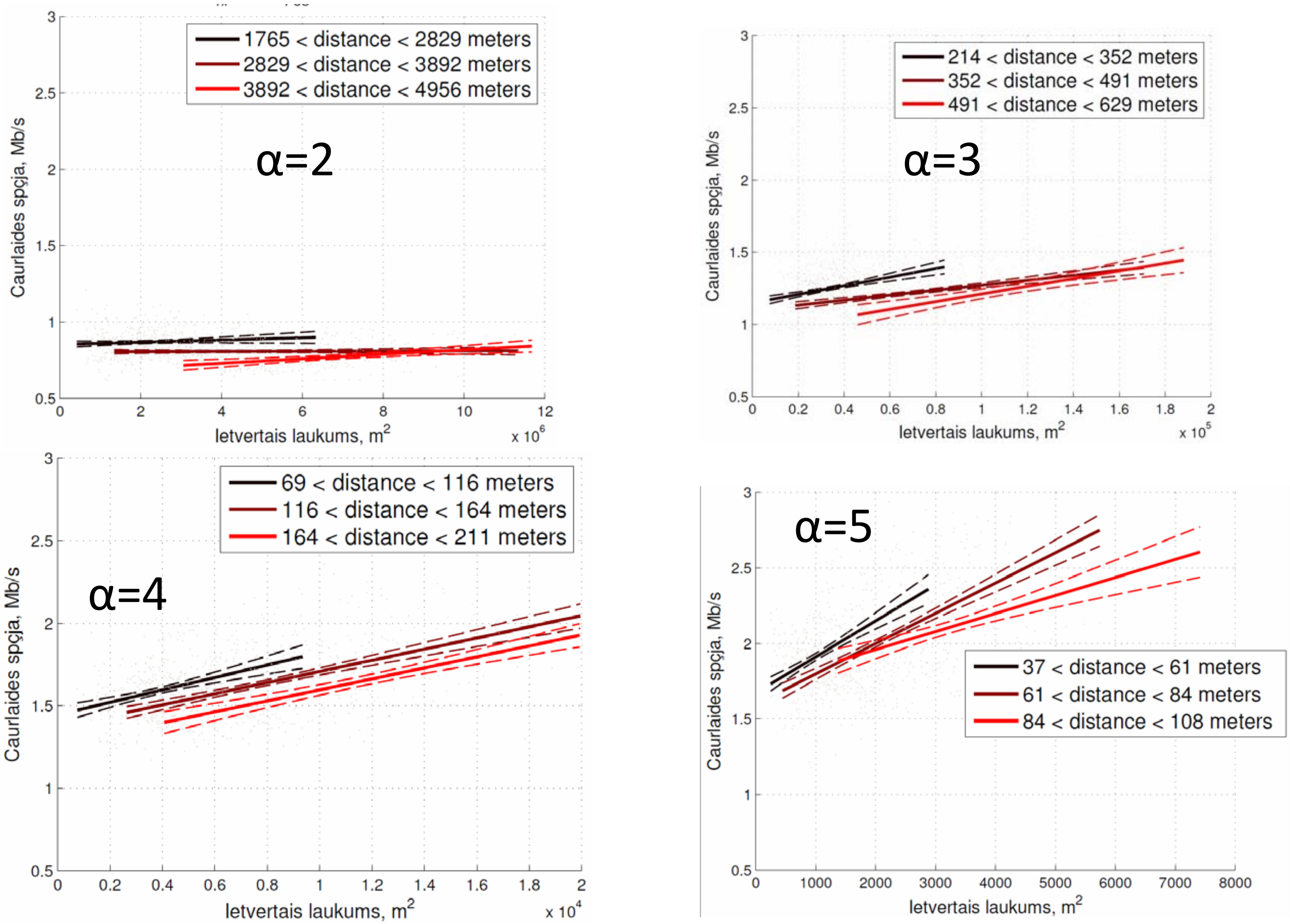
Radio viļņu izplatīšanās modelis

- Vienkāršots modelis
  - ceļa zudumi (rimšana)
  - gadījuma variācijas (fedings, neparedzami objekti)

$$\boldsymbol{P_{Rx}} = \boldsymbol{P_{Tx}} \cdot K \cdot \left[\frac{d_0}{\boldsymbol{d}}\right]^{\propto} \cdot X(\mu, \sigma)$$

Vide		α
Ārpus telpām	Brīva telpa	2
	Daudz-atstarojumu apdzīvot vide	2.7 - 5
Telpās	Tiešā redzamībā	1.6 - 1.8
	Bez tiešās redzamības	4 - 6

Ceļa zudumu parametra ietekme



Secinājumi

- Izmantota analītiska metode vairāku maršrutu analīzei
- Izstrādāts Matlab rīks bezvadu ad-hoc tīkla imitācijai
- starp maršrutu attāluma palielināšana ne vienmēr dod augstāku caurlaides spēju
  - Svarīgs faktors iesaistīto mezglu skaits
  - efektivitāte atkarīga no vides

Rīgas Tehniskā Universitāte
radioelektronikas institūts

Elastīgas antenas kompleksо parametru novērtēšana

EDI Seminārs 29.04.14

Oļegs Artamonovs
II kursa doktorants
olegs.artamonovs@rtu.lv

Rīga 2014

Elastīga (valkājama) antena

- Antena kas paredzēta darbībai tuvā zonā ar cilvēka ķermeņi. Antenu var integrēt apģērbā vai ekipējumā un lietot kopā ar sakaru ierīcēm.

Iespējami pielietojumi

- Bezvadu sensoru tīkli.
- Distances vadība
- GSM
- Telemedicīna
- Satelītu sakari
- Glābšanas radiobākas
- GPS
- Radio identifikācija RFID

Valkājamo antenu piemēri

The Tactical Vest Antenna System

www.wearableantenna.com

Valkājamo antenu piemēri

The Tactical Vest Antenna System

Optimal Frequency Range:	30 - 100Mhz
Total Frequency Range:	30 - 512Mhz
Gain:	-10dBi at 30.00Mhz
Power Input:	7 Watts
Weight:	9oz / 255.14 grams
Coverage:	Omni-directional
Interconnect Wire Length:	12"
Radio Compatibility:	PRC-148, PRC-152, PRC-117, etc.
Radio Connector:	TNC
Vest Type:	Any with SAPI/ESAPI Pouches
Impedance:	50ohm

www.wearableantenna.com

Valkājamo antenu piemēri

www.pharad.com

Valkājamo antenu parametri

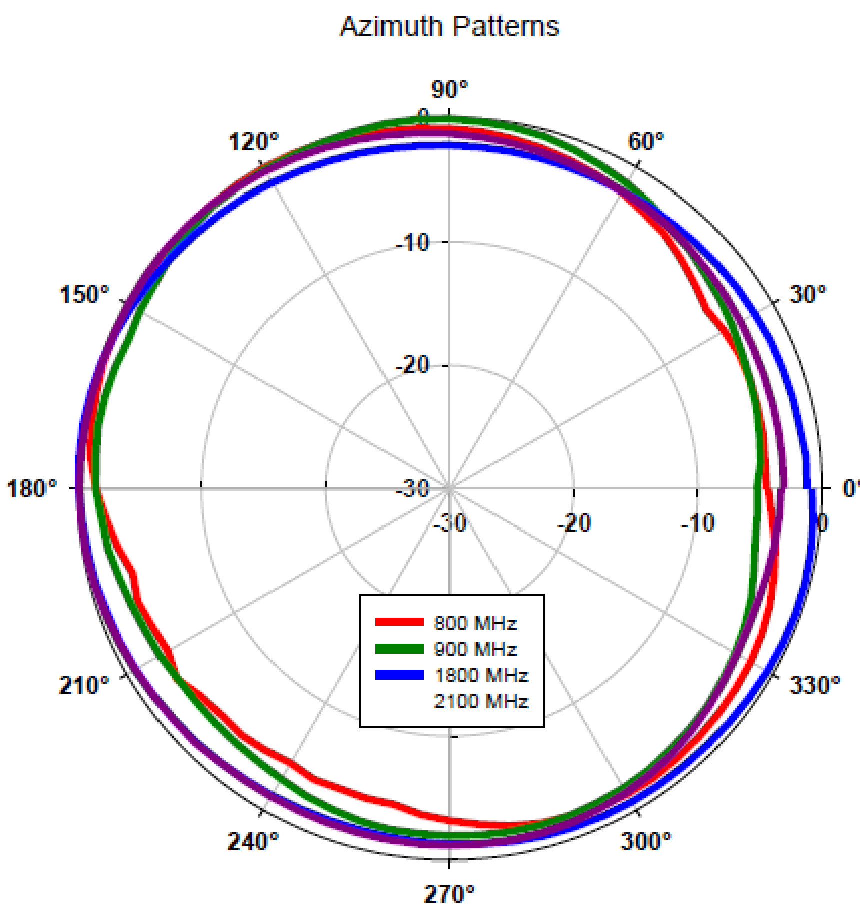
Quad Band GSM Wearable Antenna

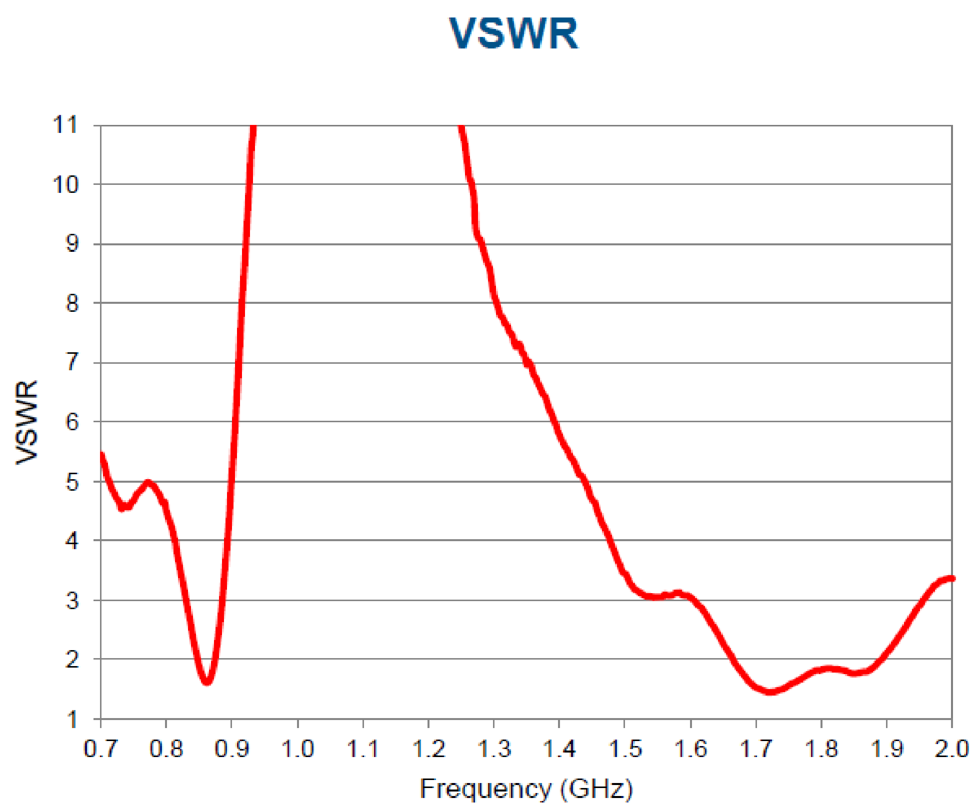
Model Number	BW-800/900/1800/1900	BW-800/900/1800/1900-D
Frequency	800/900/1800/1900 MHz	
Gain†	-1 dBi	1 dBi
Pattern	Near omni-directional	
Polarization	Vertical	
VSWR†	< 2.5:1	
Radiator Size (L × W × D)	2.5″ × 4.0″ × 0.5″	
Cable Length	16.5″	20″
Radiator Weight	< 2 oz	2.4 oz
Connector Type	SMA	

Valkājamo antenu parametri

www.pharad.com

Quad Band GSM Wearable Antenna





Esošo antenu trūkumi:

- Mazs pastiprinājuma koeficents (~0 – 1 dBi)
- Nav izteiktas virziena darbības:

  cilvēks tiek apstarots elektromagnētisko lauku

  cilvēka ķermenis ienes papildus zudumus antenā.

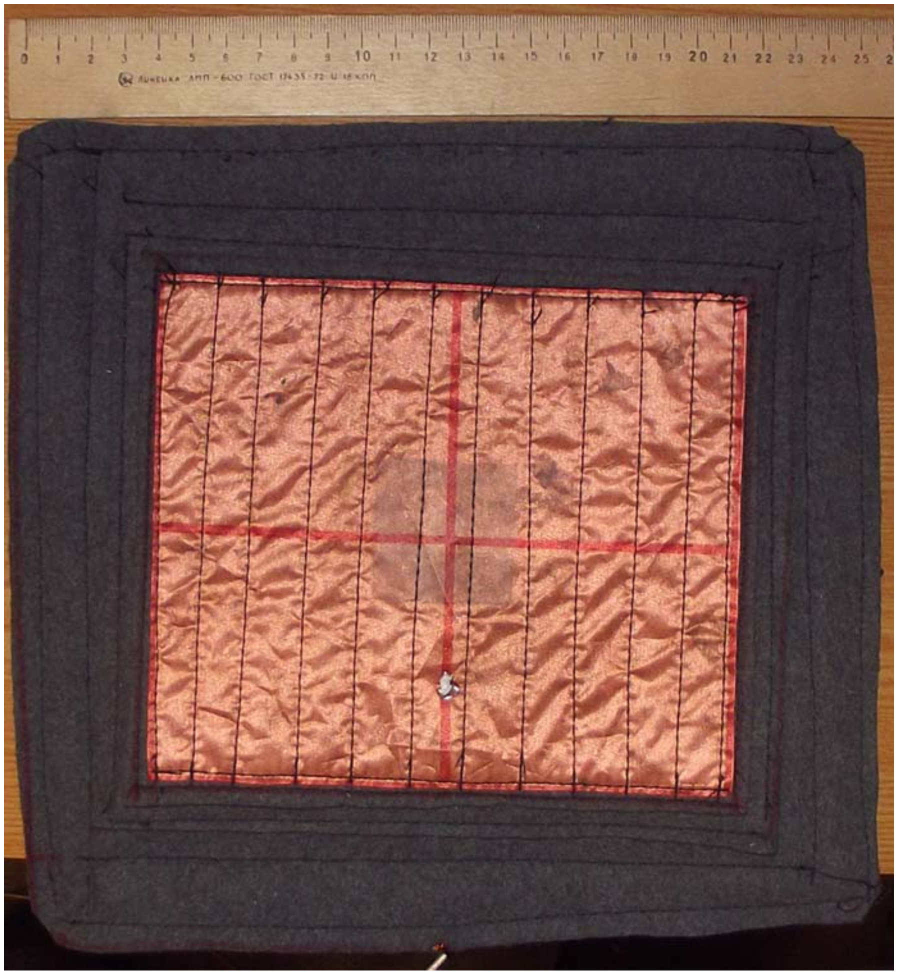
Antenas izstrādāšana

Galvenie apsvērumi

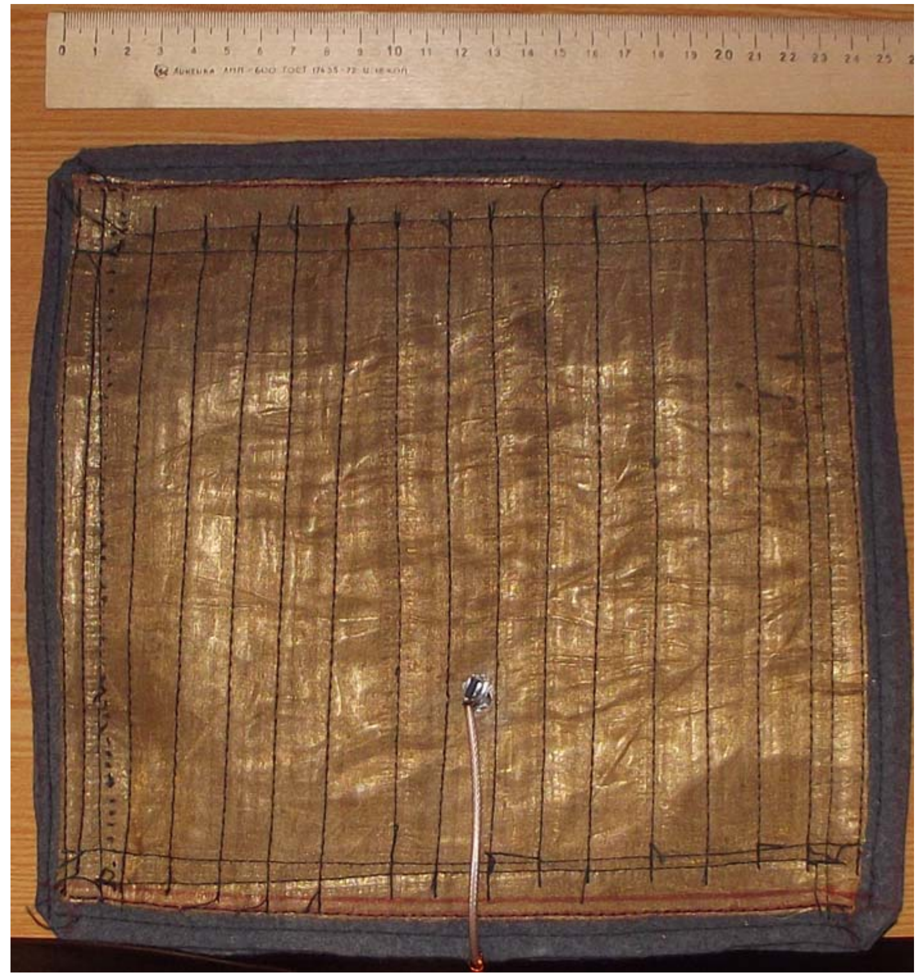
- Prognozējama darba frekvence 870 MHz
- Stāvviļņa koeficents < 2.0
- Elektrovadoša auduma pielietošana
- Laba aizmugures starojuma slapēšana
- Plakana un lokama konstrukcija

Antenas konstrukcija

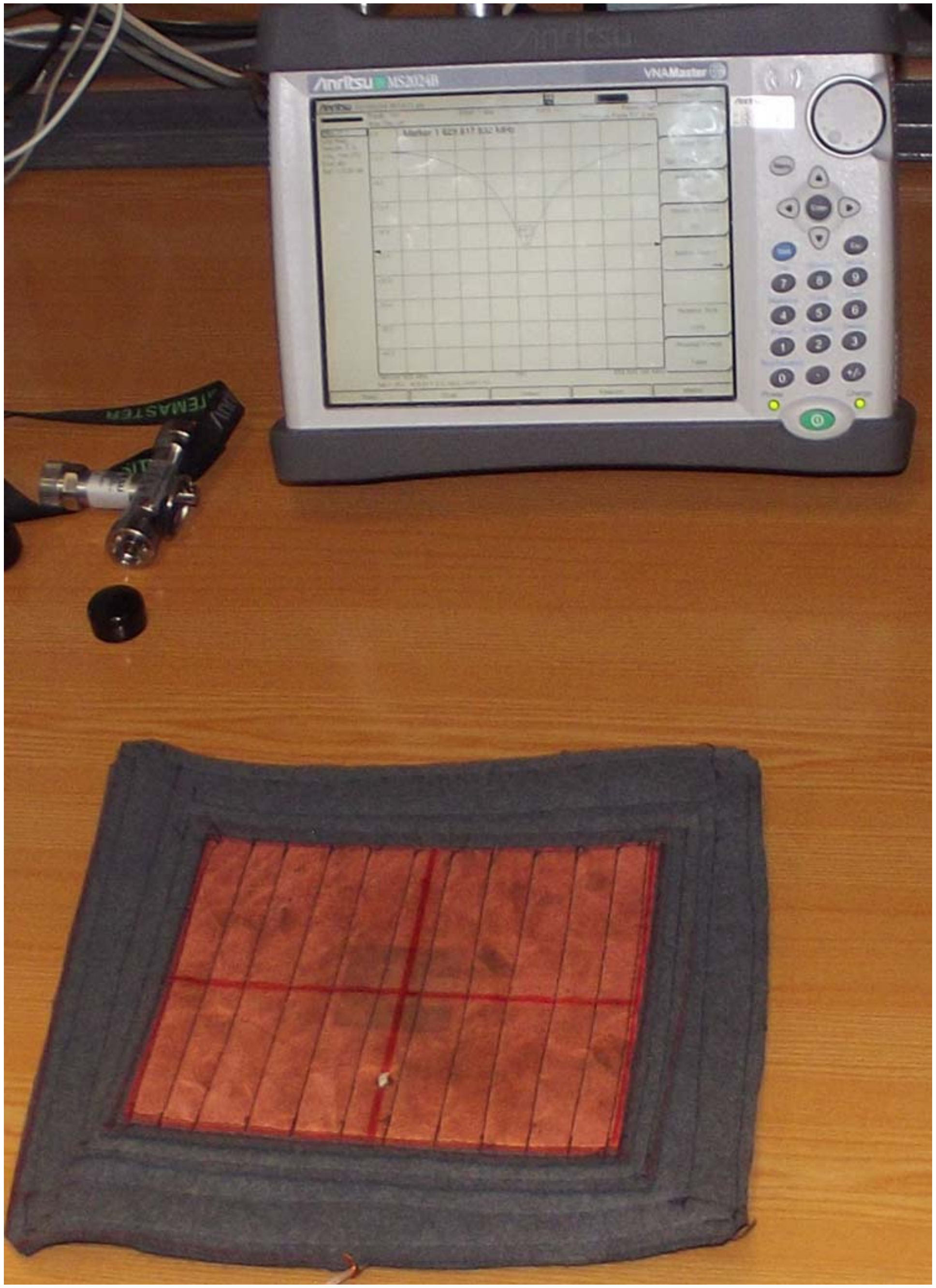
Starotājs



Ekrāns



Antenu parametru pētīšana

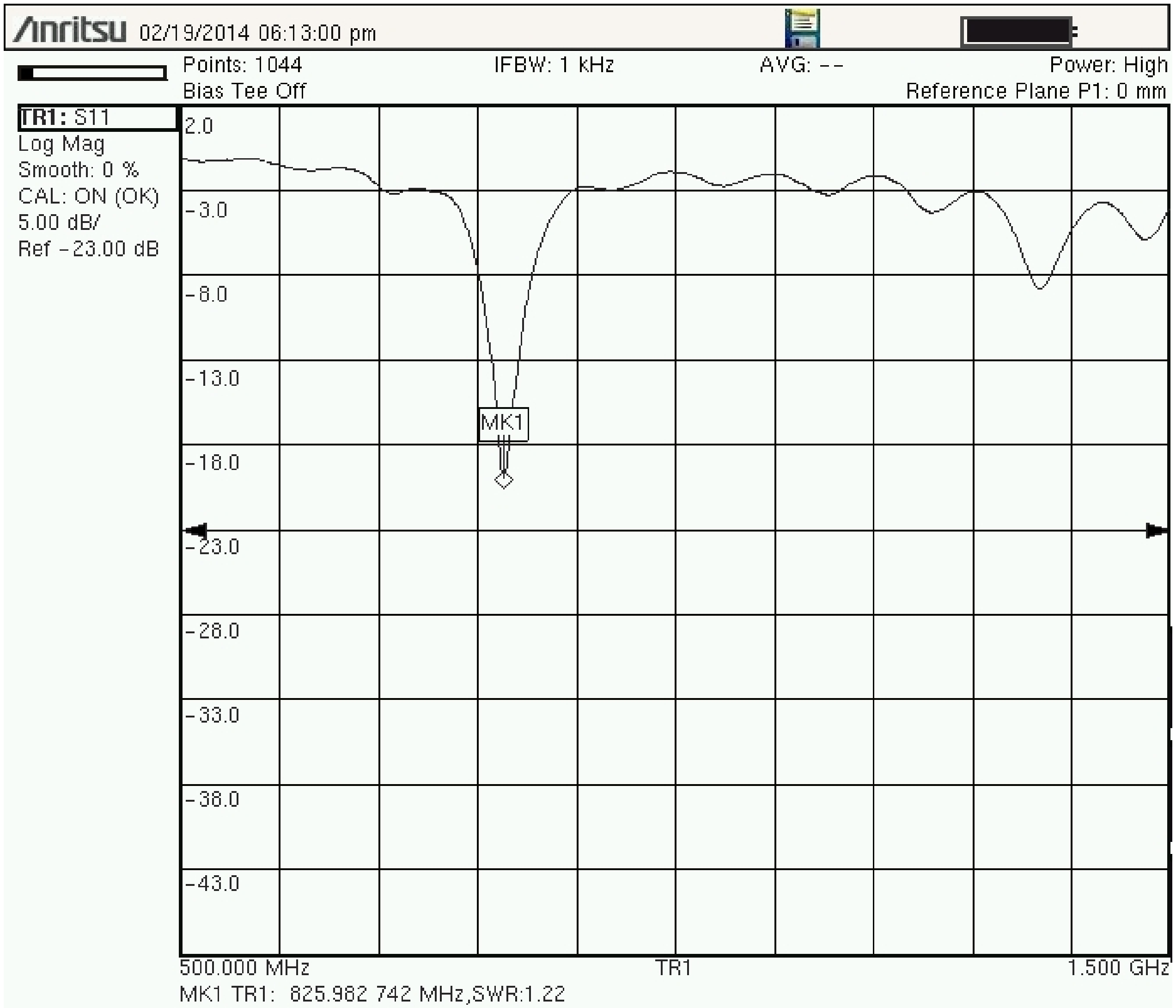


Antenu parametru pētīšana

Anritsu ķēžu analizators

S11, SWR, S12

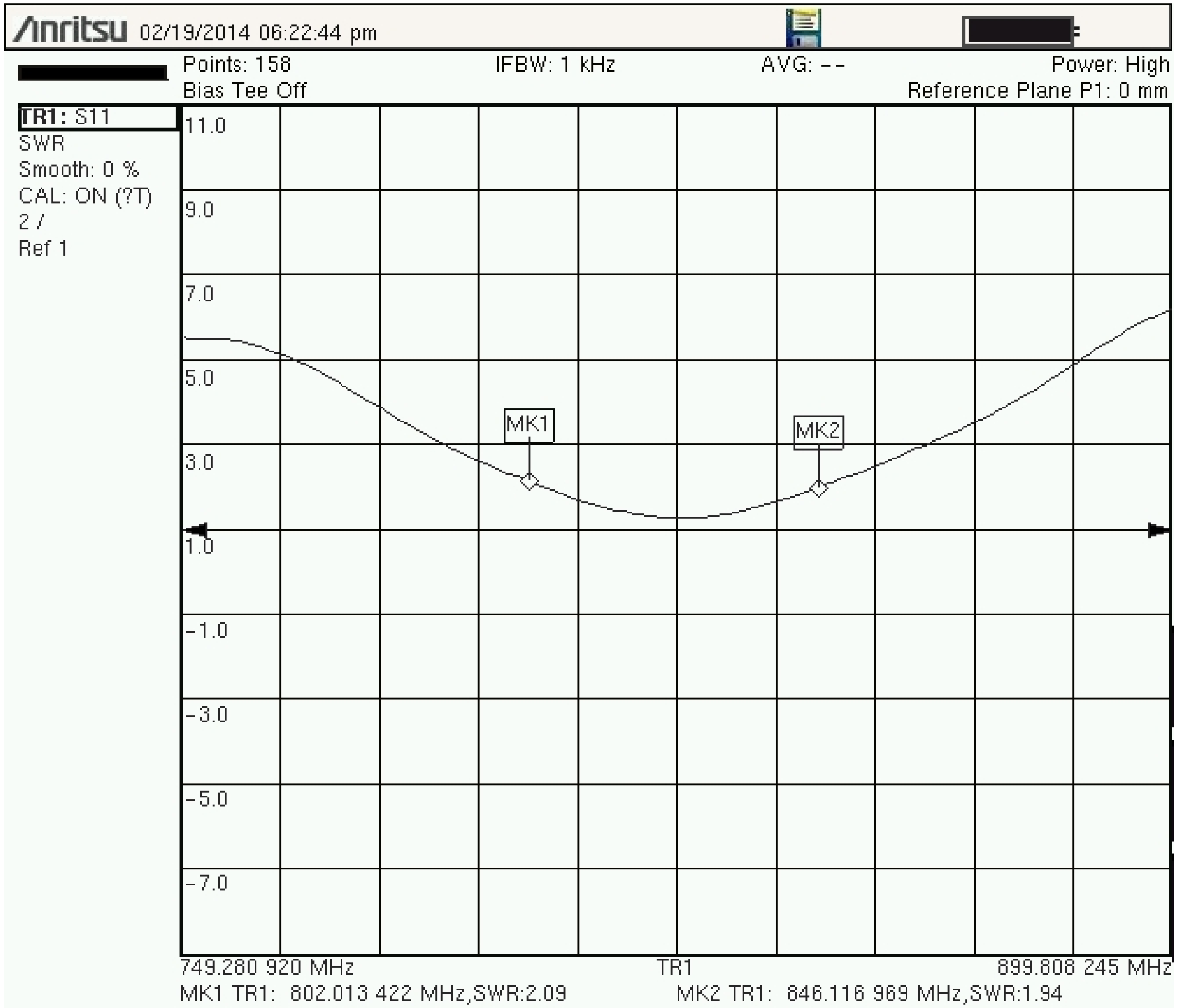
Stāvviļņa koeficents (SWR) joslā 500 – 1500 MHz



SWR min = 1.2

F = 826 MHz

SWR joslā 750 – 900 MHz



Darbības josla (pie SWR < 2): 800 – 845 MHz

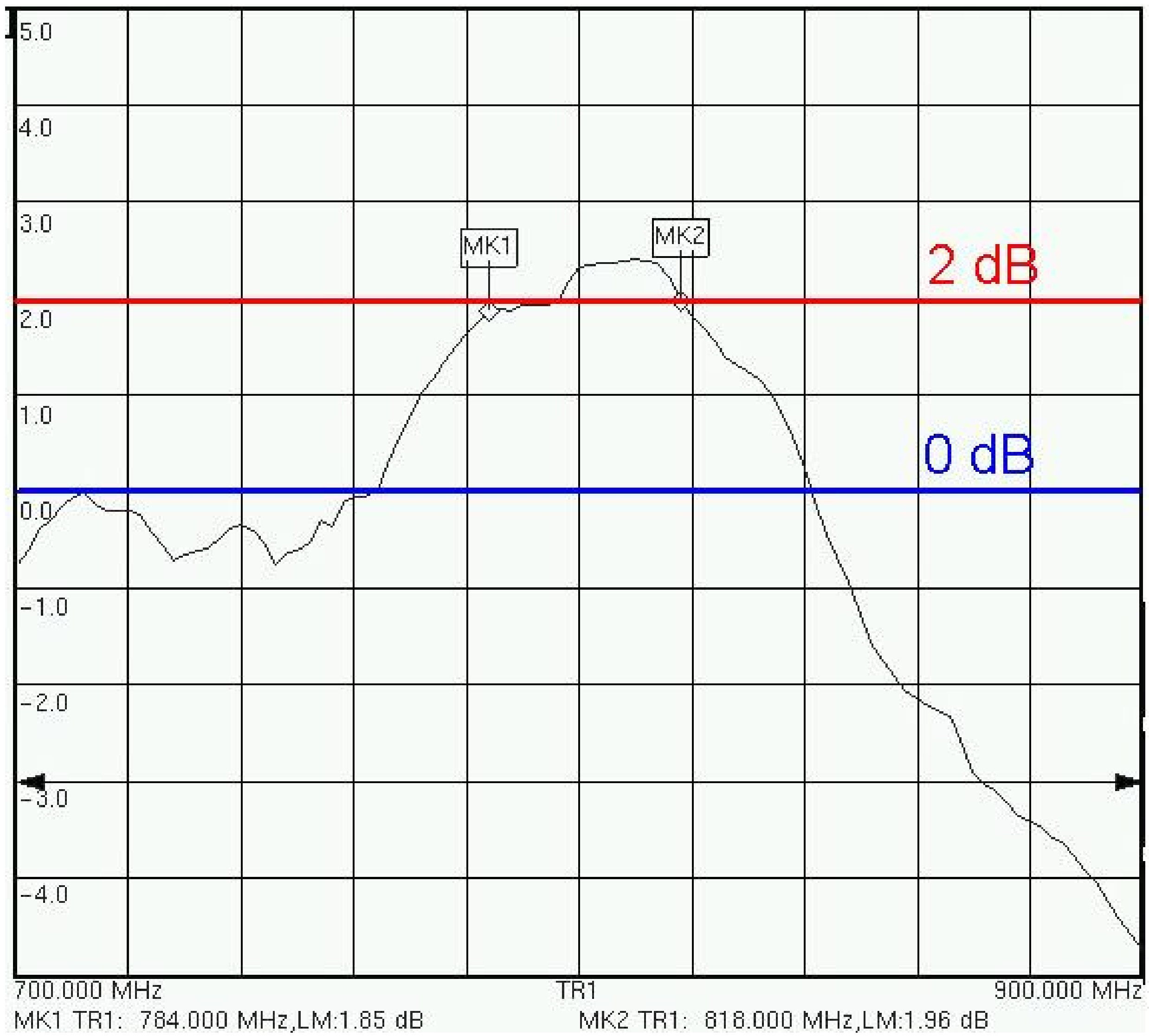
Starošanas efektivitātes noteikšana

Kanāla kalibrēšana RUPORS →RUPORS

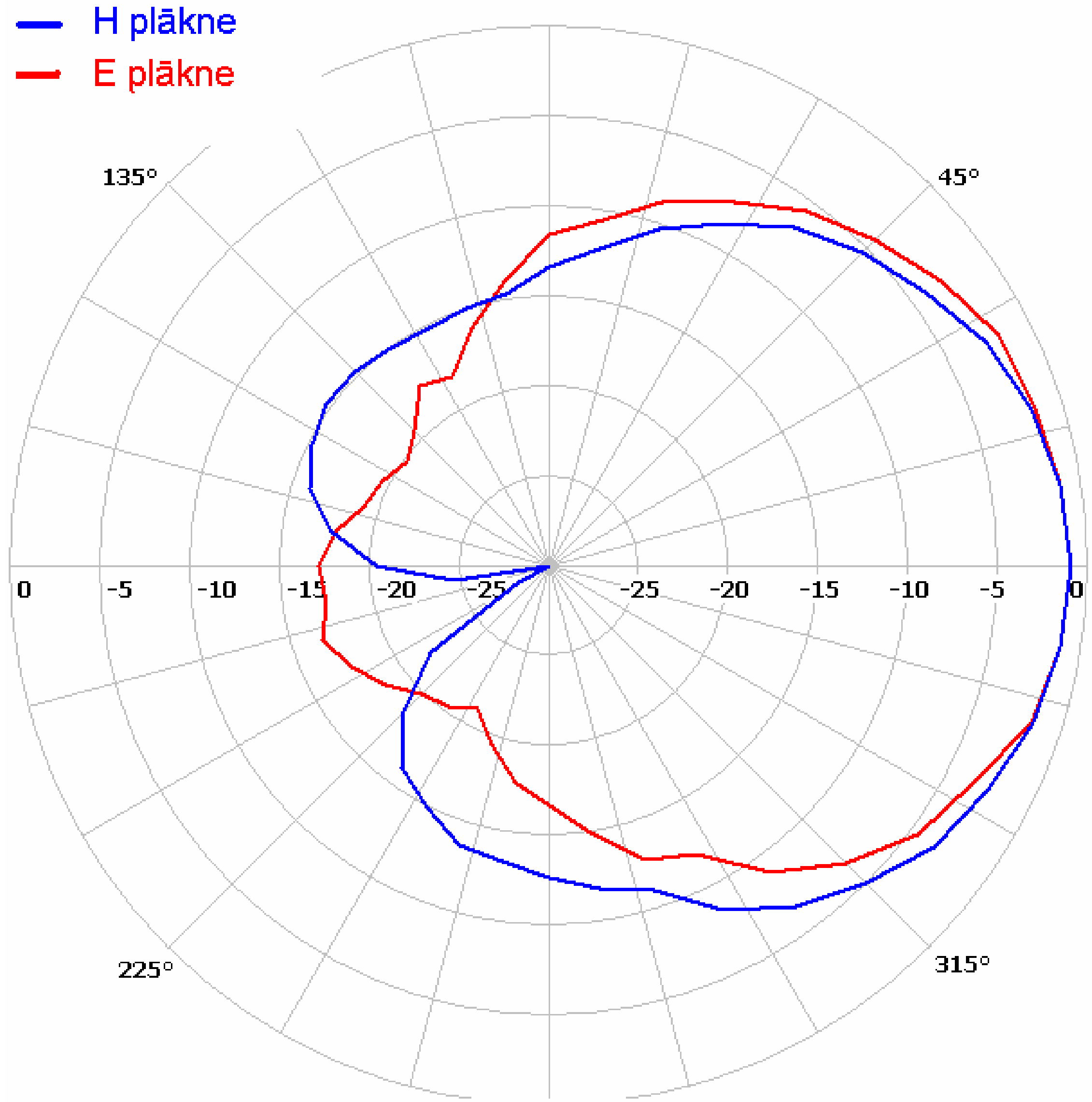
Vieno ruporu aizvietojam ar pētāmo antenu

0 dB – nokalibrēts kanāls RUPORS → RUPORS

+2 dB joslā 780 – 820 MHz RUPORS → Tekstila antena



Starojuma diagramma



Kopsavilkums

Minimālais SWR (826 MHz)	1.2
Antenas darbības josla (SWR < 2.0)	800 – 820 MHz
Relatīvs pastiprinājums salīdzinot ar R&S HF906 rupora antenu joslā 800 – 820 MHz	> 2 dB
Galvenās vāles platums E plaknē - 6 dB līmenī	~ 120 grādi
Galvenās vāles platums H plaknē - 6 dB līmenī	~ 110 grādi

Paldies par uzmanību