



**Hanzehogeschool
Groningen**

University of Applied Sciences

Innovatie(ve toepassingen) met 5G

Lunchsessie Samenwerking Noord

**share your talent.
move the world.**



<https://www.rtvnoord.nl/video/885463/hanze-student-ontwerpt-veiligheidsvest>

Even voorstellen

- Jos Bredek
- Hanzehogeschool, HBO-ICT
- Docent-onderzoeker
- 5G





Lunchsessie Samenwerking Noord - 5G



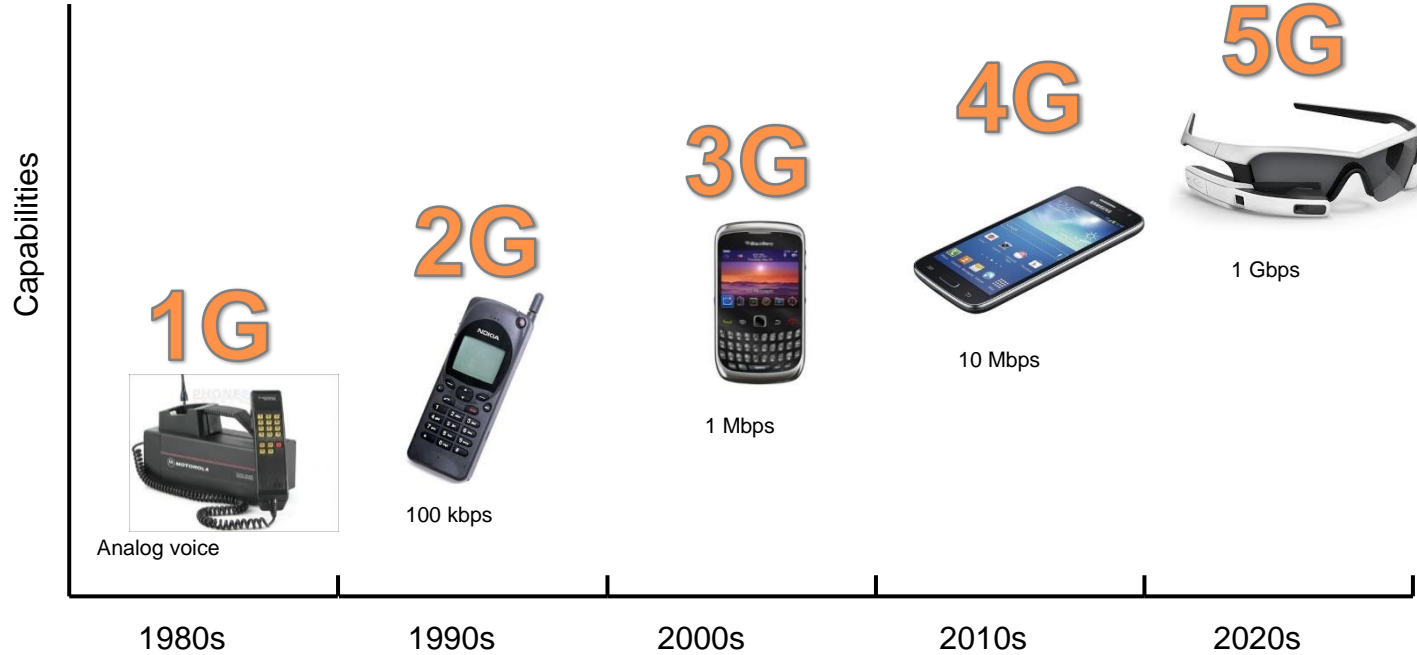
share your talent. move the world.

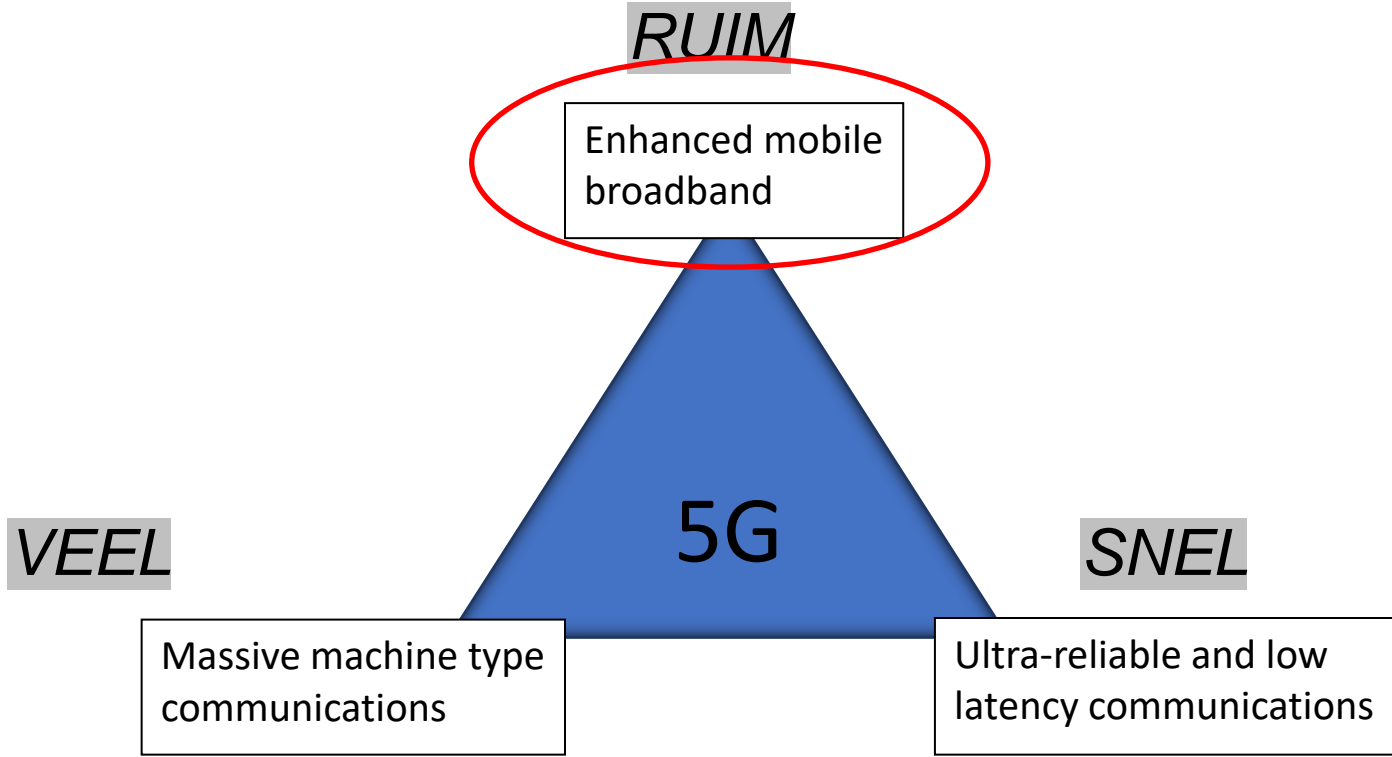


Founding Fathers 5Groningen



source:





Snelheid ??

Capaciteit - vertraging

Enhanced mobile broadband - capaciteit



Vergroten capaciteit (1)



Vergroten capaciteit (2)



Vergroten capaciteit (3)



Snel 5G via 3,5 GHz-band weer uitgesteld

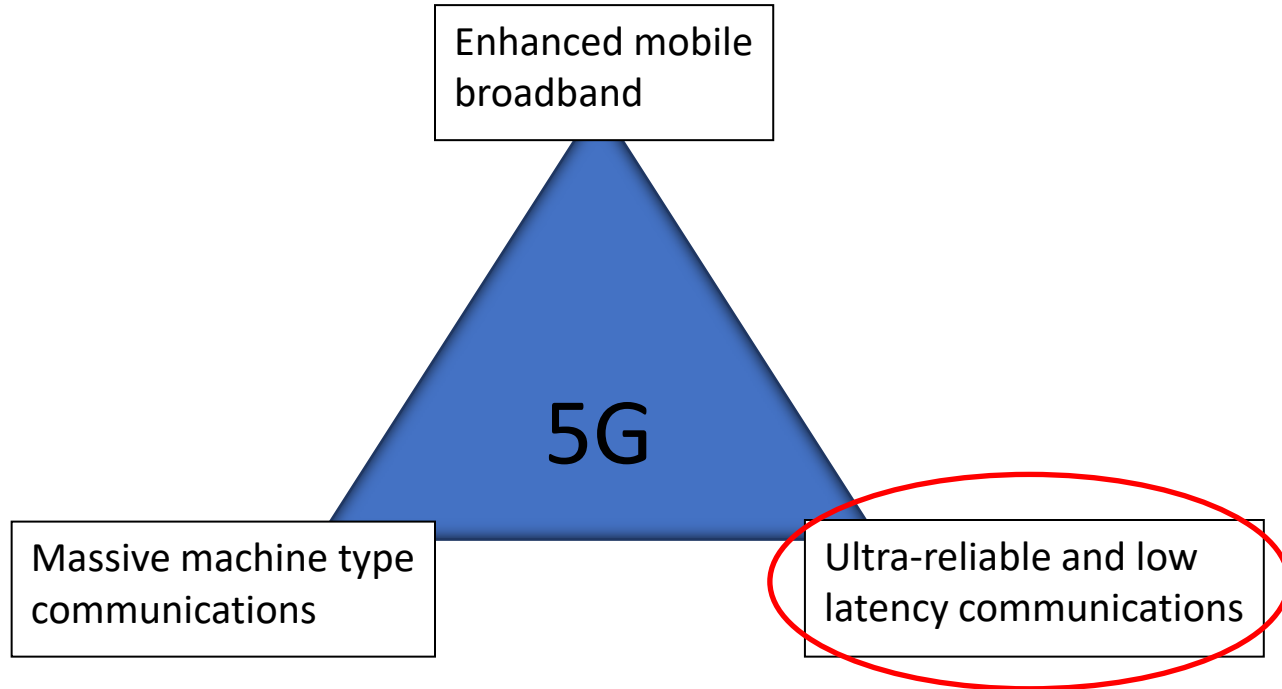
1 september 2021 10:03 Min leestijd



De veiling voor de 3,5GHz-frequentieband, die belangrijk is voor een sneller 5G-netwerk, zal niet in april 2022 plaatsvinden, zoals eerder was gepland. De komst van een echt snel 5G-netwerk wordt daarom uitgesteld tot een later moment, schrijft demissionair staatssecretaris Maria Keijzer (Economische Zaken) in een brief aan de Tweede Kamer.

```
pi@raspberrypi:~/Politievest/rpi $ iperf3 -c 10.230.20.61 -u -b 0 -p 554
Connecting to host 10.230.20.61, port 554
[ 5] local 192.168.1.4 port 36371 connected to 10.230.20.61 port 554
[ ID] Interval           Transfer    Bitrate      Total Datagrams
[ 5]  0.00-1.00    sec    74.3 MBytes    623 Mbits/sec    53770
[ 5]  1.00-2.00    sec    77.4 MBytes    649 Mbits/sec    56050
[ 5]  2.00-3.00    sec    77.3 MBytes    649 Mbits/sec    56000
[ 5]  3.00-4.00    sec    77.1 MBytes    647 Mbits/sec    55820
[ 5]  4.00-5.00    sec    77.0 MBytes    646 Mbits/sec    5740
[ 5]  5.00-6.00    sec    77.3 MBytes    649 Mbits/sec    5990
[ 5]  6.00-7.00    sec    77.6 MBytes    651 Mbits/sec    6160
[ 5]  7.00-8.00    sec    77.4 MBytes    649 Mbits/sec    56060
[ 5]  8.00-9.00    sec    77.6 MBytes    651 Mbits/sec    56200
[ 5]  9.00-10.00   sec    77.6 MBytes    651 Mbits/sec    56170
- - - - -
[ ID] Interval           Transfer    Bitrate      Jitter    Lost/Total Datagrams
[ 5]  0.00-10.00   sec    770 MBytes    646 Mbits/sec    0.000 ms    0/557960 (0%) sender

iperf Done.
pi@raspberrypi:~/Politievest/rpi $
```



Latency ?

Hoe lang duurt het (gemiddeld) om van iets een **antwoord** te krijgen

vertraging

Latency

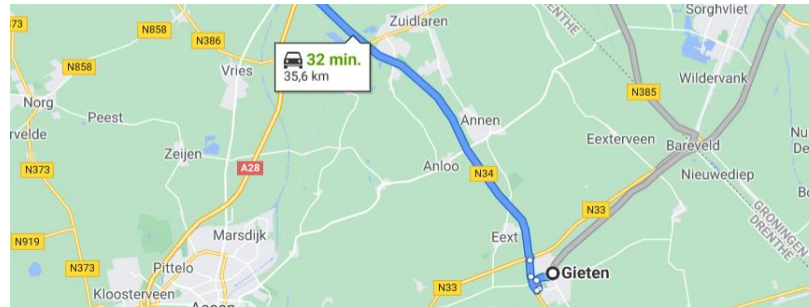


via N34 en A28

32 min.

Snelste route, normale verkeersdruk

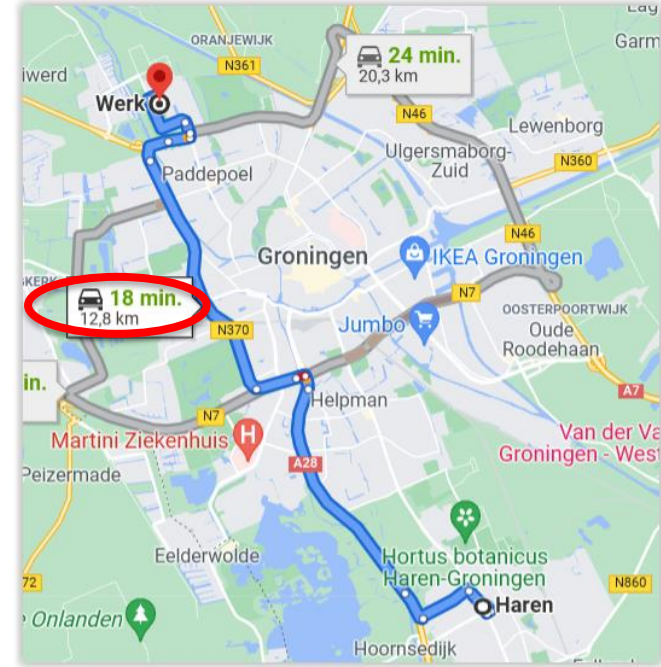
35,6 km



(Verkleinen) latency - 1



Verkleinen latency - 2



Verkleinen latency - 3



Latency – aantal knooppunten

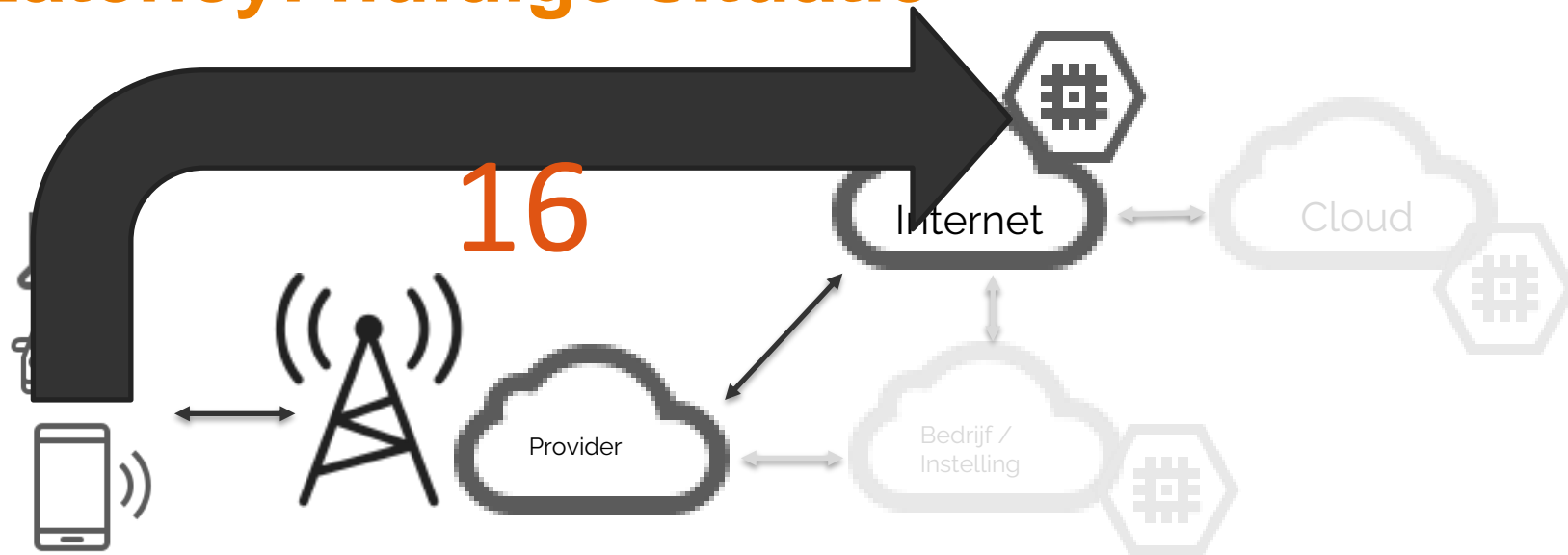
```
C:\Users\jos>tracert -d google.nl

Tracing route to google.nl [216.58.212.227]
over a maximum of 30 hops:

  0  1  2  3  4  5  6  7  8  9  10 11 12 13 14 15 16
  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
  0  1  2  3  4  5  6  7  8  9  10 11 12 13 14 15 16
  1  3 ms  2 ms  2 ms 192.168.5.175
  2  7 ms  5 ms  5 ms 192.168.1.1
  3 11 ms  7 ms  5 ms 192.168.178.1
  4  *      *      *      Request timed out.
  5 19 ms 26 ms 20 ms 213.51.195.177
  6 21 ms 18 ms 54 ms 213.51.158.20
  7 19 ms 15 ms 23 ms 213.51.64.58
  8 119 ms 17 ms 20 ms 213.46.182.22
  9 21 ms 16 ms 19 ms 108.170.241.225
 10 22 ms 21 ms 19 ms 108.170.241.236
 11 20 ms 16 ms 17 ms 216.239.43.27
 12  *      29 ms  *      108.170.234.119
 13 25 ms 56 ms 29 ms 64.233.175.112
 14 37 ms 23 ms 23 ms 108.170.246.161
 15 28 ms 25 ms 24 ms 216.239.63.219
 16 48 ms 26 ms 23 ms 216.58.212.227
```

Hop	Count	IP	Name	Avg
1	53	192.168.5.175	192.168.5.175	4,2
2	53	192.168.1.1	unknown	8,6
3	53	192.168.178.1	192.168.178.1	10,7
		-		
5	53	213.51.195.177	asn-rc0002-cr101	16,9
6	52	213.51.158.20	asd-rc0001-cr101	21,3
7	52	213.51.64.58	nl-ams14a-ri1-ae	23,1
8	52	213.46.182.22	10ge-1-4.cr1.ams	20,3
9	52	108.170.241.161	108.170.241.161	20,0
10	29	108.170.241.172	108.170.241.172	18,6
11	27	209.85.255.197	209.85.255.197	19,0
12	18	108.170.237.243	108.170.237.243	24,9
13	26	216.239.57.206	216.239.57.206	26,0
14	52	74.125.242.65	74.125.242.65	26,2
15	52	142.250.215.125	142.250.215.125	27,9
16	52	142.250.178.3	google.nl	31,0
	52		Round Trip (ms)	31,0

Latency: huidige situatie



= computernetwerk

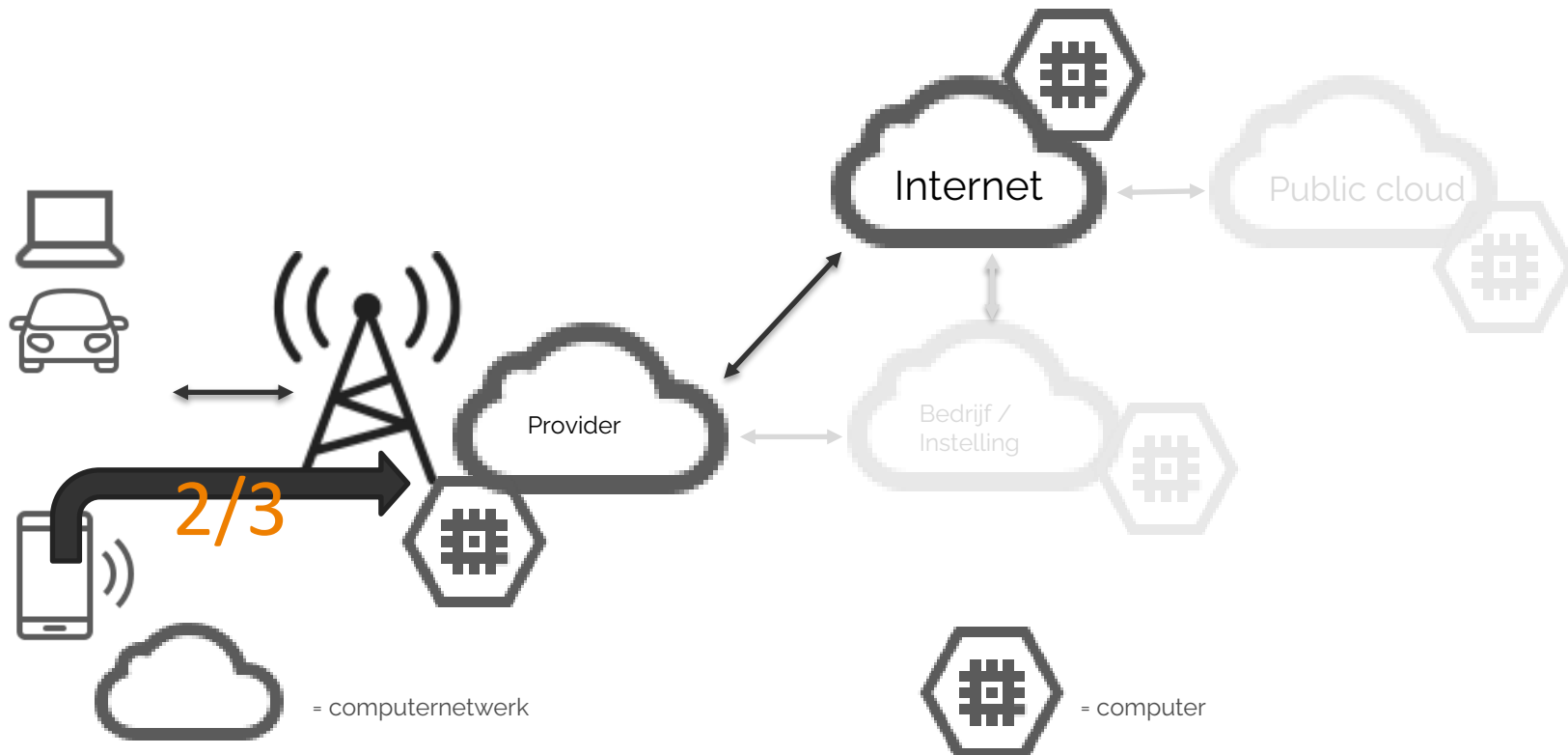
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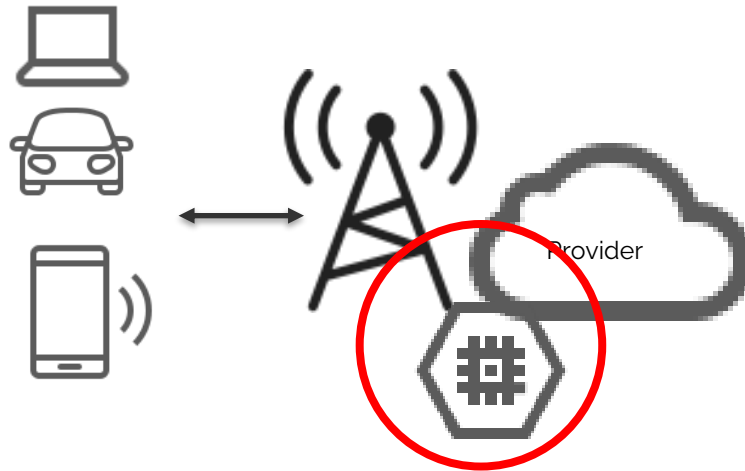
= computer

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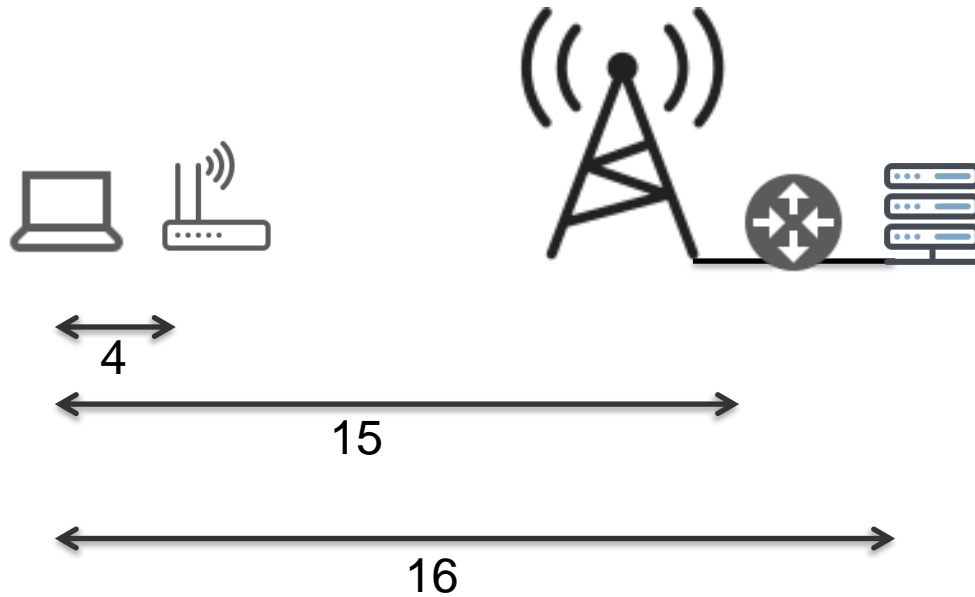
Low latency... hoe dan?



Edge computing



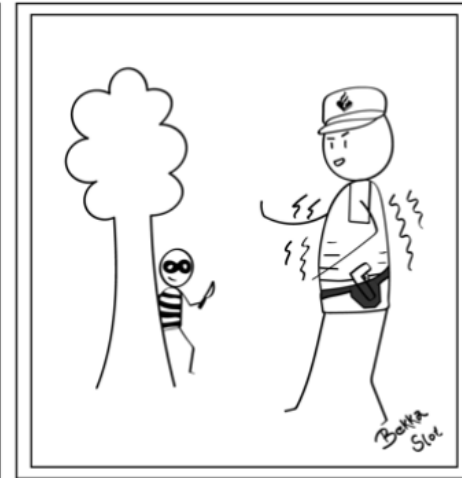
Hop	Count	IP	Name	Avg
1	244	192.168.1.1	mywebui.net	3,9
2	244	10.45.0.1	10.45.0.1	14,6
3	244	10.230.20.61	10.230.20.61	15,8
	244		Round Trip (ms)	15,8





8 á 9

Slim vest



Slim veiligheidsvest voor politie winnende idee 5G Student Battle

Door Omroep het Hogeland 16 november 2020 16:44



Slim vest

Beperkingen, door weinig ruimte

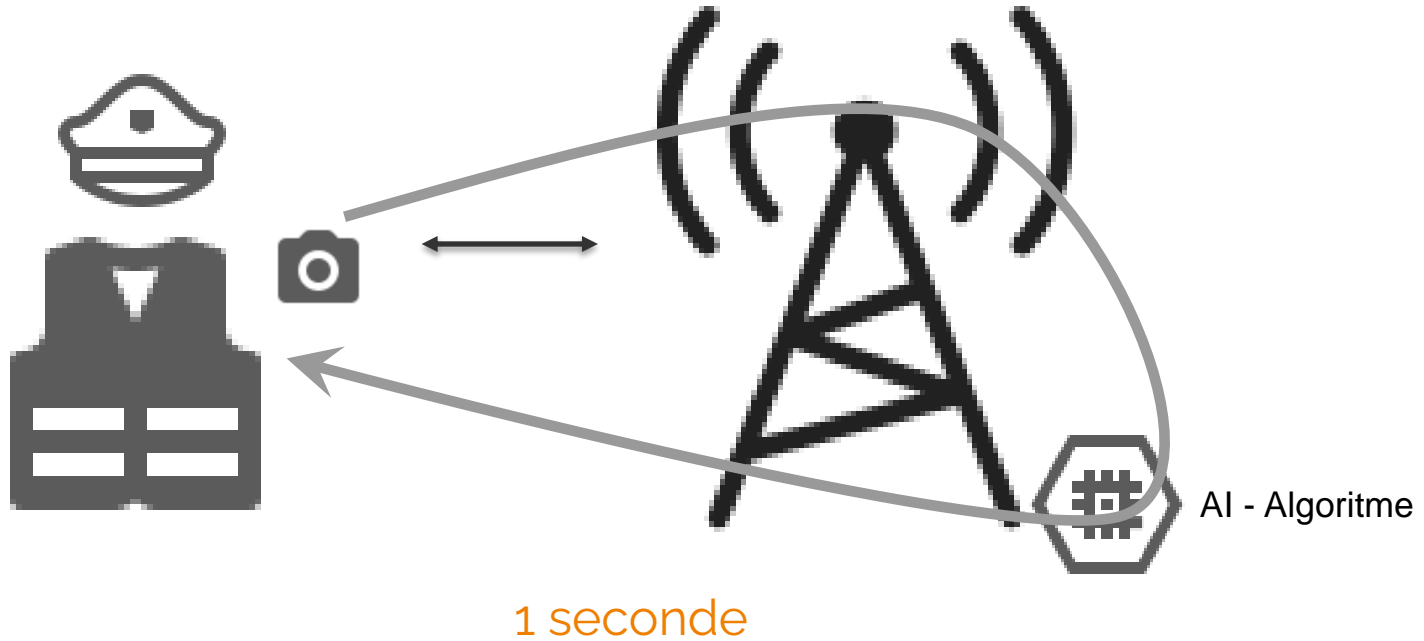
- Beperkte accu
- Weinig rekenkracht

Eisen:

- Herkenning van wapens
- Snelle beslissing + “alarm”



Slim vest - keten



Slim vest



Lunchsessie Samenwerking Noord - 5G

TNO innovation
for life

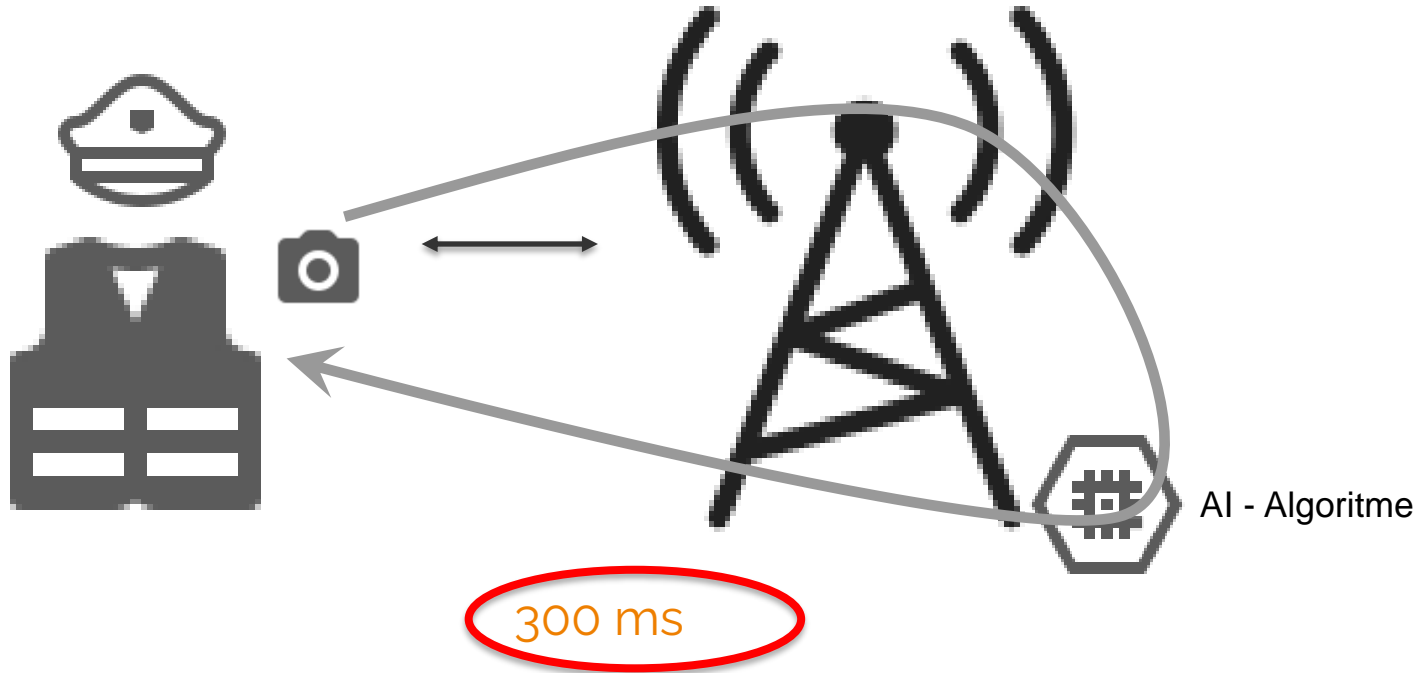
vmware®



samenwerking
noord 10 jaar
we unite

share your talent. **move** the world.

En?



Slim X



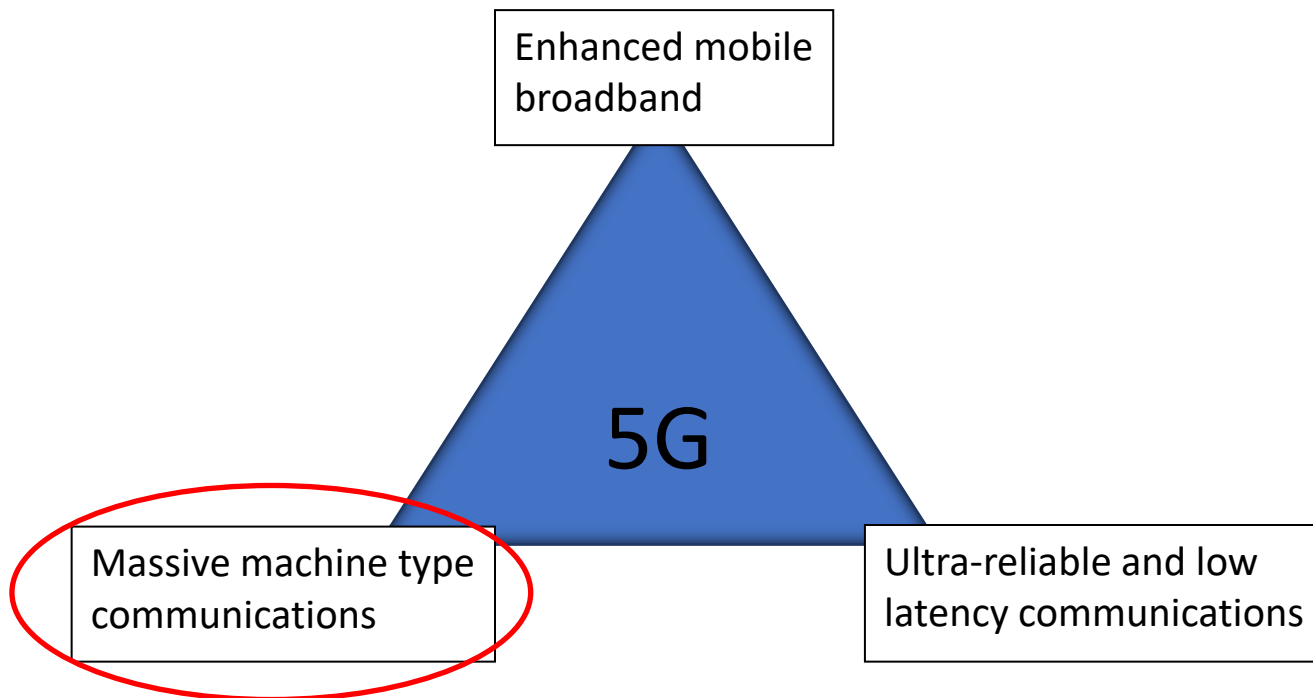
1000



750



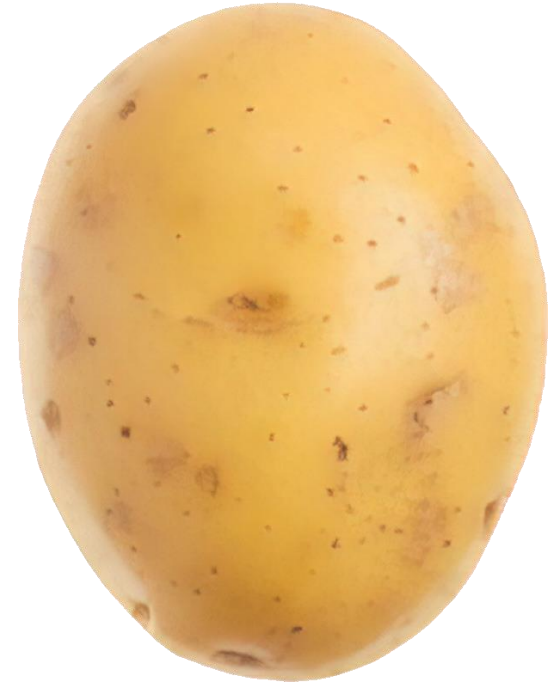
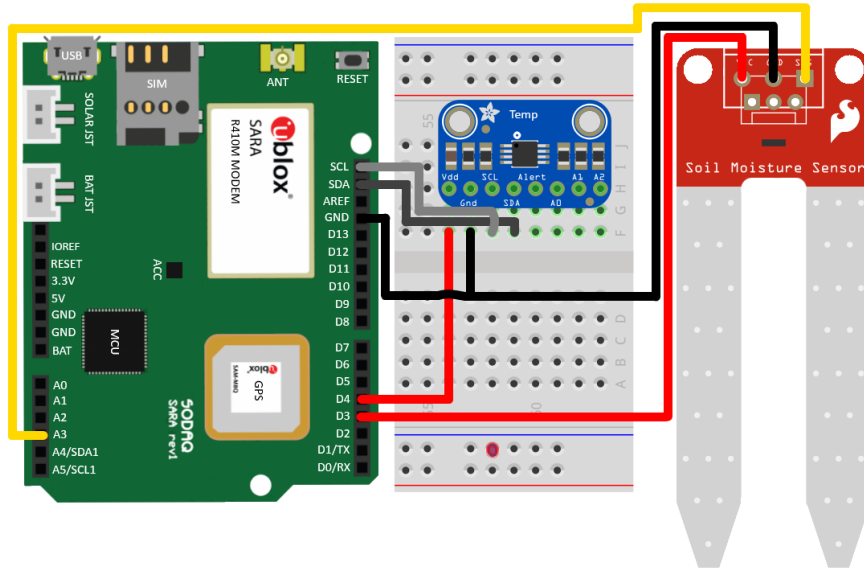
200



Slimme aardappel v2.0



Slimme aardappel v2.0



Slimme aardappel v2.0



$^{\circ}\text{C}$

Vochtigheid



X,Y,Z

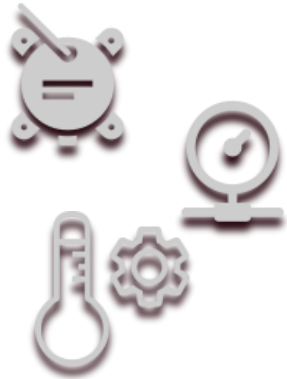
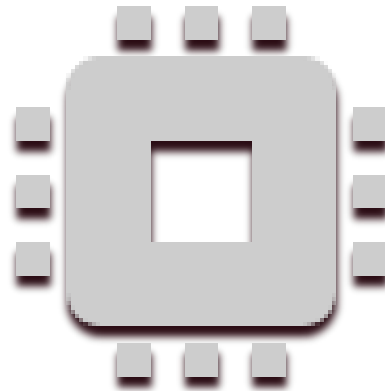


O_2
 CO_2



1

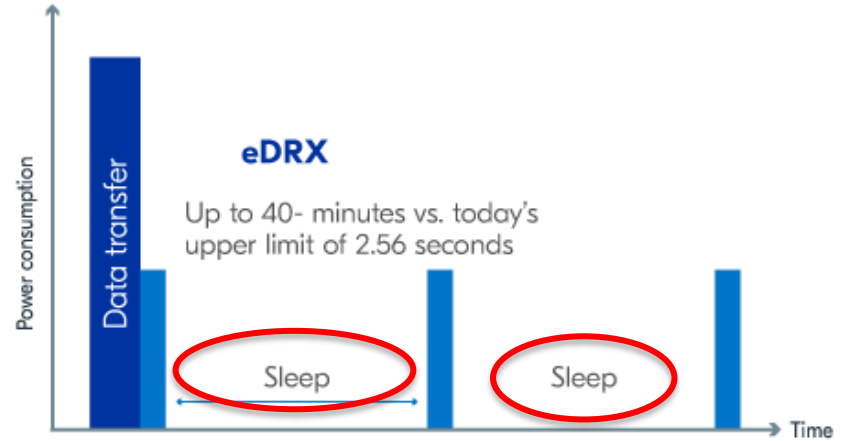
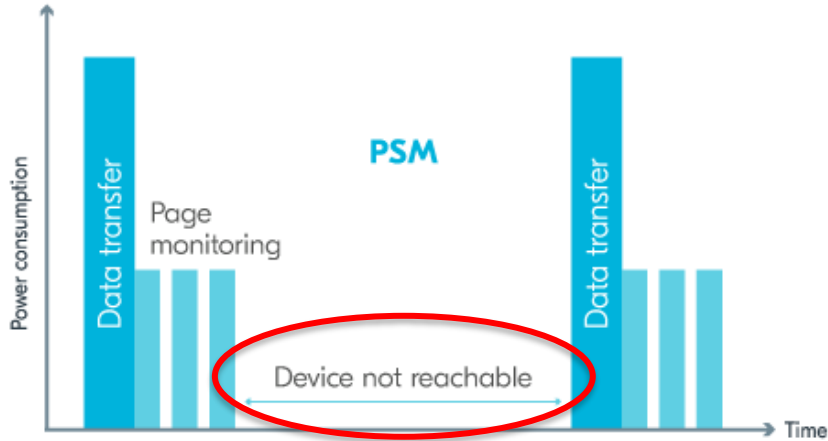
Slimme aardappel v2.0





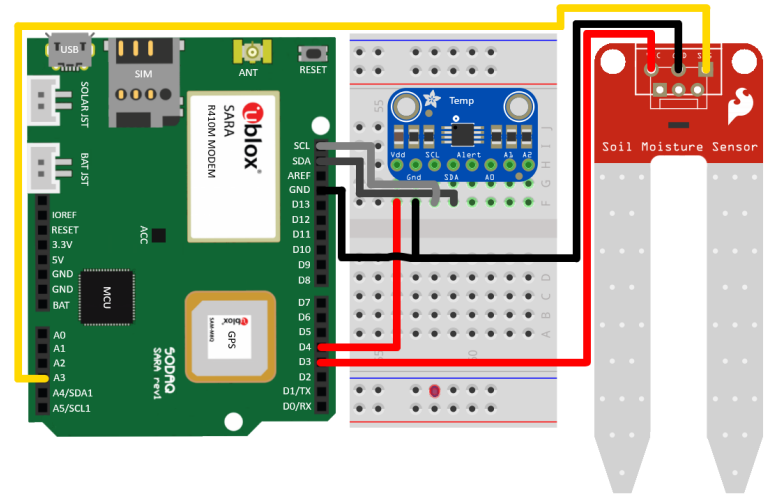
~~4 OF 5?~~

4 EN 5!



Slimme aardappel v2.0

- LTE-NB IoT : PowerSafeMode
- CPU : slaapmodus
- Sensoren
 - Uit
 - Accelerometer: standby



Slimme aardappel v2.0



$^{\circ}\text{C}$

Vochtigheid



X,Y,Z



O_2
 CO_2



27



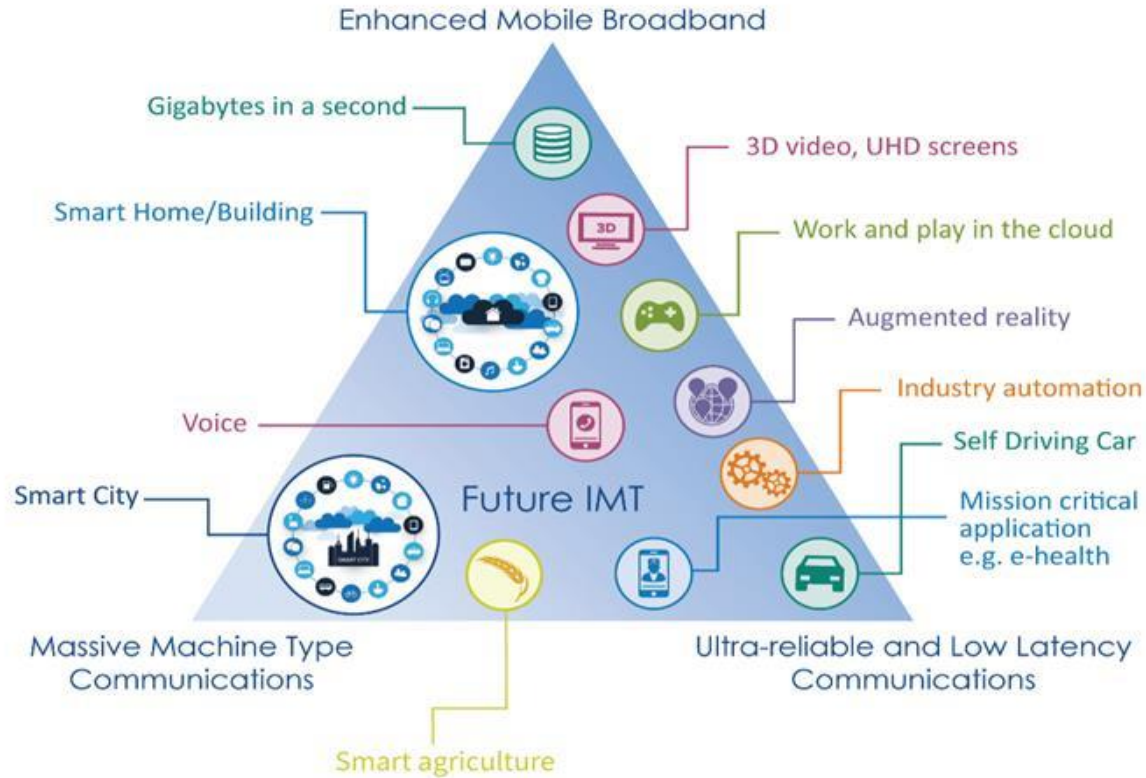
27

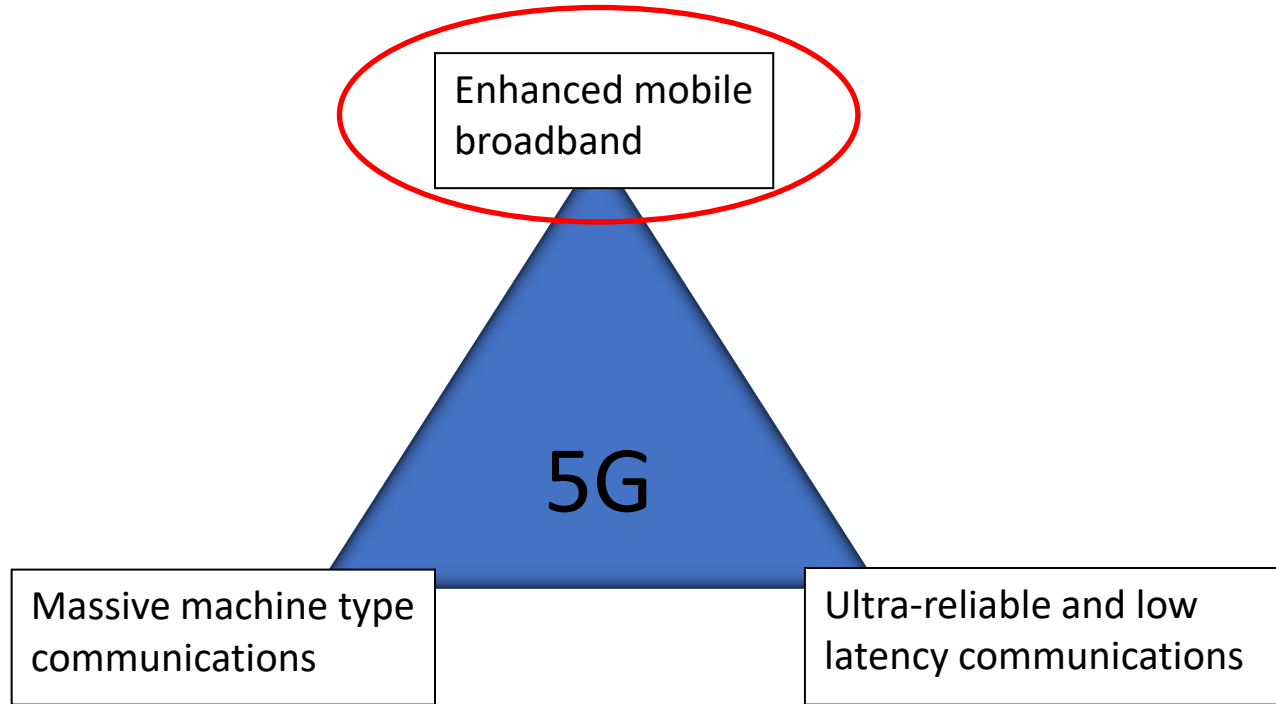
#keren zenden per dag	Levensduur (jaren)
1	27
2	13
8	3
24	1



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Augmented/virtual reality



A CNBC render of the sort of map a soldier could see if they looked down.

Virtual Reality mogelijkheden 5G

Studenten onderzoeken mogelijkheden VR bij sport

In samenwerking met
ACLO)>>>
STUDENTENSPORT
GRONINGEN



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