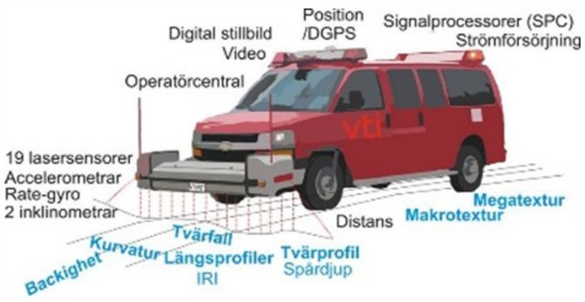
Road roughness and inventory survey with smartphones

Micke Kedback
Market Representative
Roadroid
Micke.kedback@roadroid.com

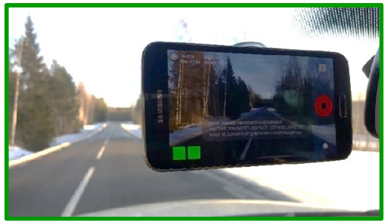
Some challenges with road surveying

- Carrying out road surveys can be complex and expensive
- It requires professional skills, appropriate technology and devices.
- Consequently, the number of surveys of roads, and especially rural and low-volume roads, tends to be low or subjective



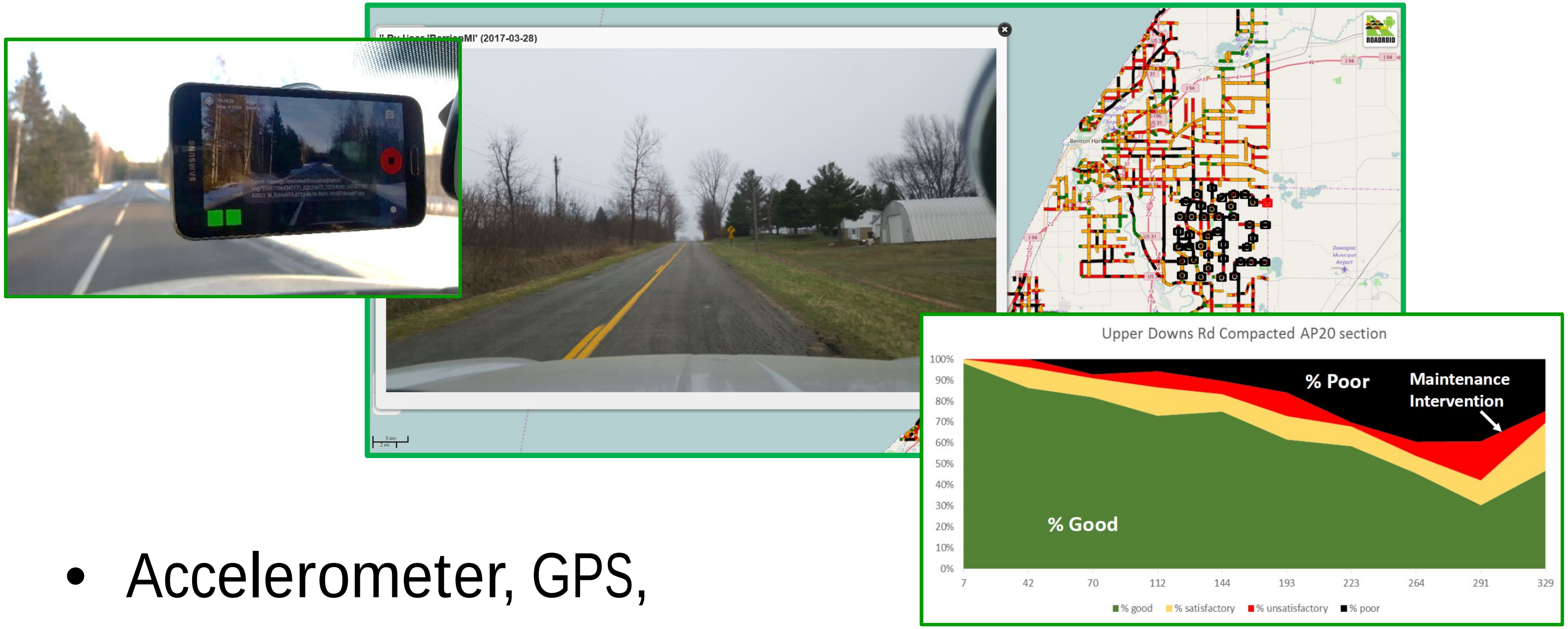
Road survey using smartphones

- To use smartphones is very efficient and cost-effective
- Smartphone technology is easily accessible by easy to use technologies and devices.
- Smarthone app to capture IRI, photos and video, using Accelerometer, Camera & GPS
- has helped road agencies all over the world to outreach more roads and especially rural and low volume roads.



How does it work?

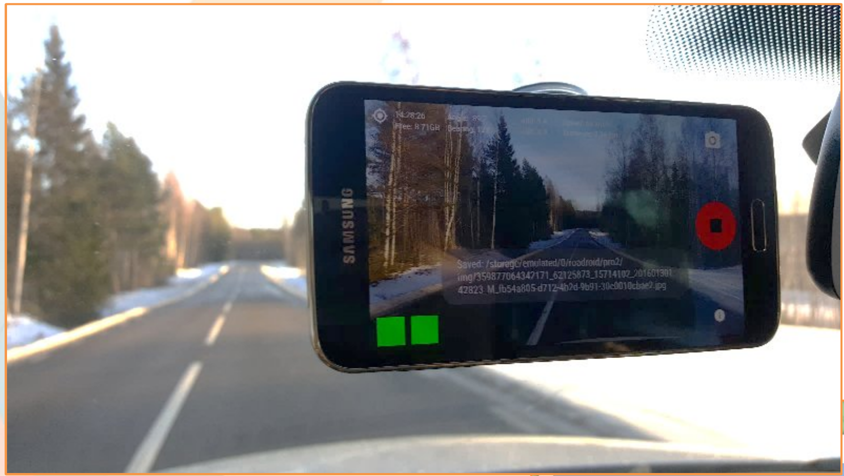
Smartphone Road Surveying



- Accelerometer, GPS, Camera

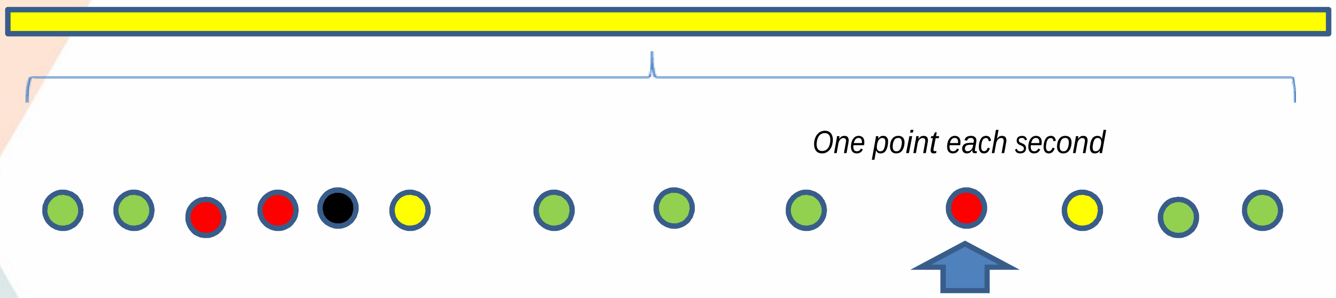
Capture IRI
– and photos

100 m – 1,6 km



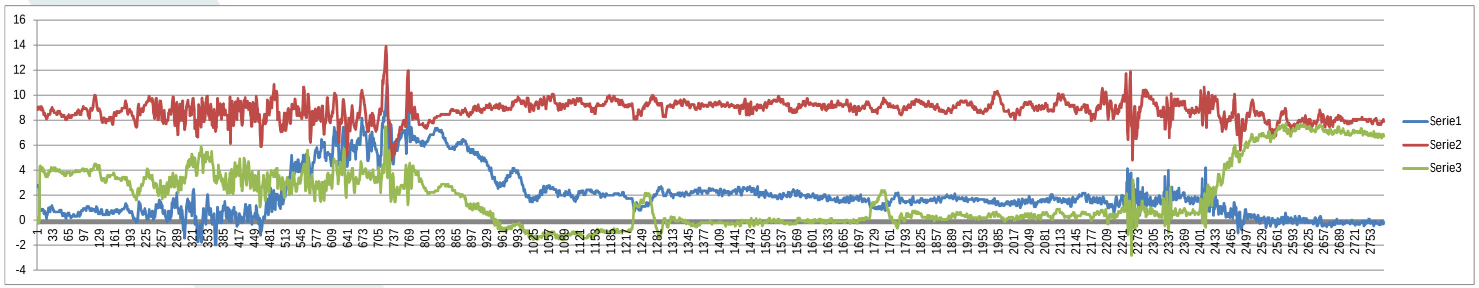
How does it work?

Points - matched to a road section



(X,Y RC) 620029.012, 6782994.850, 3,5

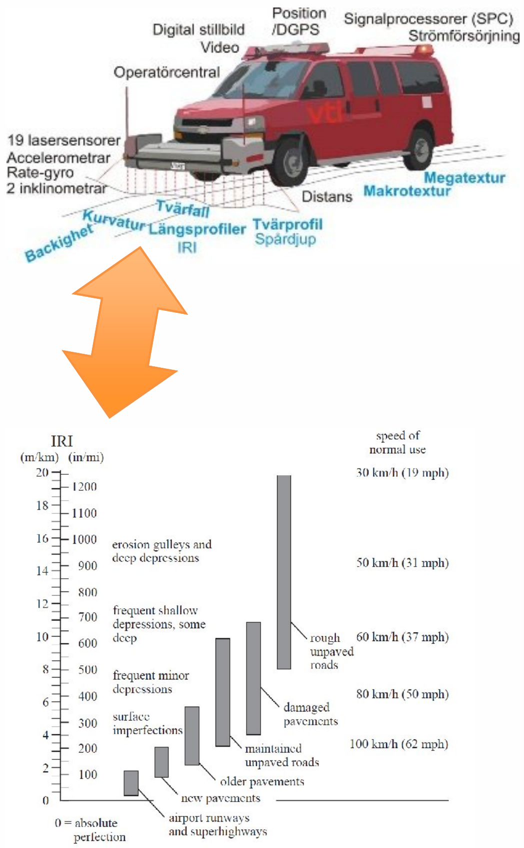
Analyse 100 vibrations -> 1 value per second



International Roughness Index

http://en.wikipedia.org/wiki/International_Roughness_Index

- World Bank defines 4 Information Quality Levels (IQL) :
  - IQL1 - Precision profiles, down to 20 m
  - IQL2 - Other (older) profilometric methods
  - IQL3 - IRI by correlation/vibration response
  - IQL4 - Subjective rating (pen+paper)



How accurate is smartphone surveying?

- University of Auckland
  - Myles Johnston (2013). *Roadroid has an 81% similarity to Laser data and can represent the roughness felt by a road user to a 'good' level*.

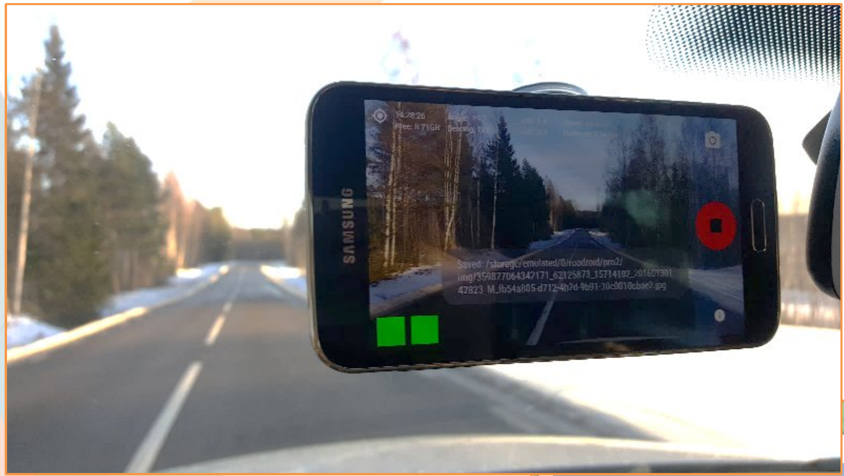
- The World Bank + University of Pretoria
  - Schlotjes, Visser, Bennett (2014) *...within the accuracy limits of an IQL-3 device of +/-20 % of the IRI, the equipment satisfied the need! Roadroid has great potential as a low-cost, practical device for measuring road roughness at IQL-3 level*.

Roadroid Road survey system overview

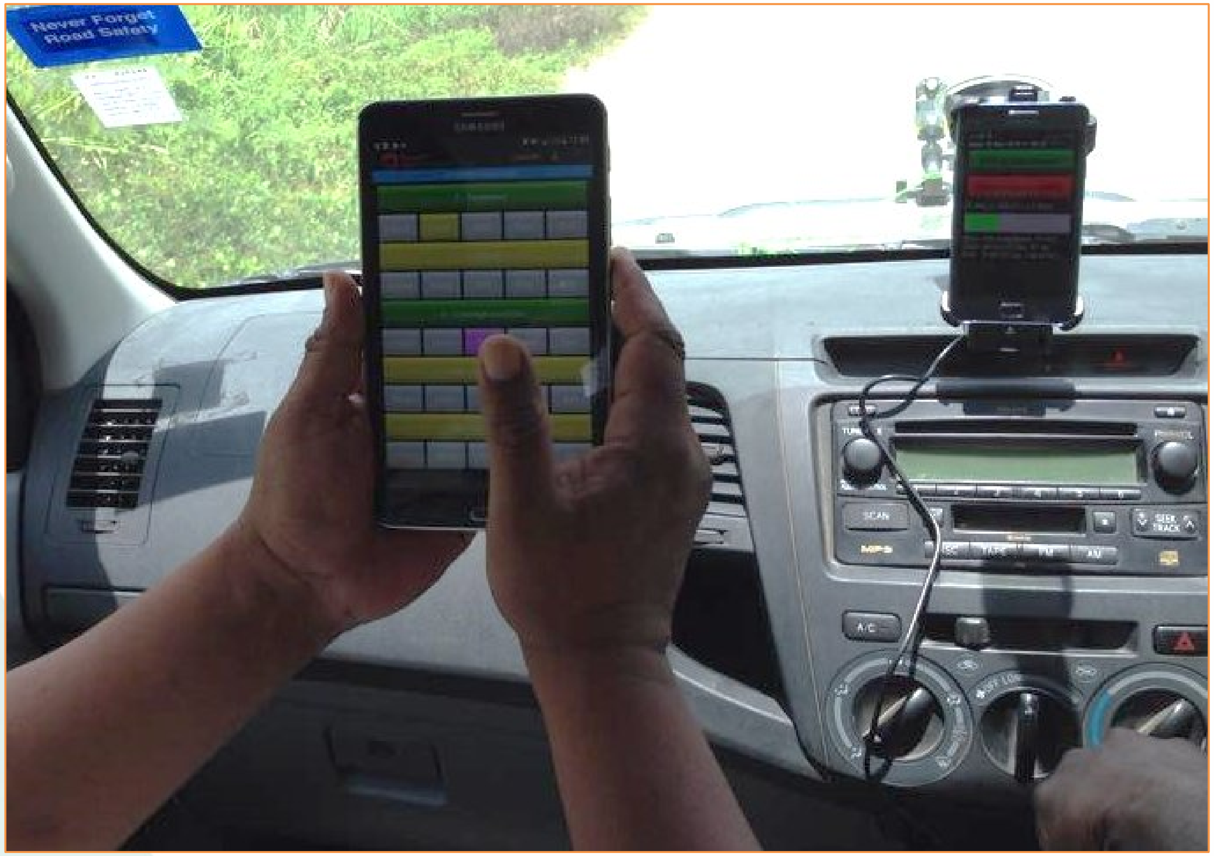
- Roadroid pro – for measuring & analysing road roughness
- Roadroid Road Inventory
- Roadroid Event Manager
- Roadroid Traffic Count with Sensbit^{TM} Traffic Sensor
- RDMS - Internet Road Data Management System

Capture IRI
– and photos

100 m – 1,6 km



Road inventory



Road inventory

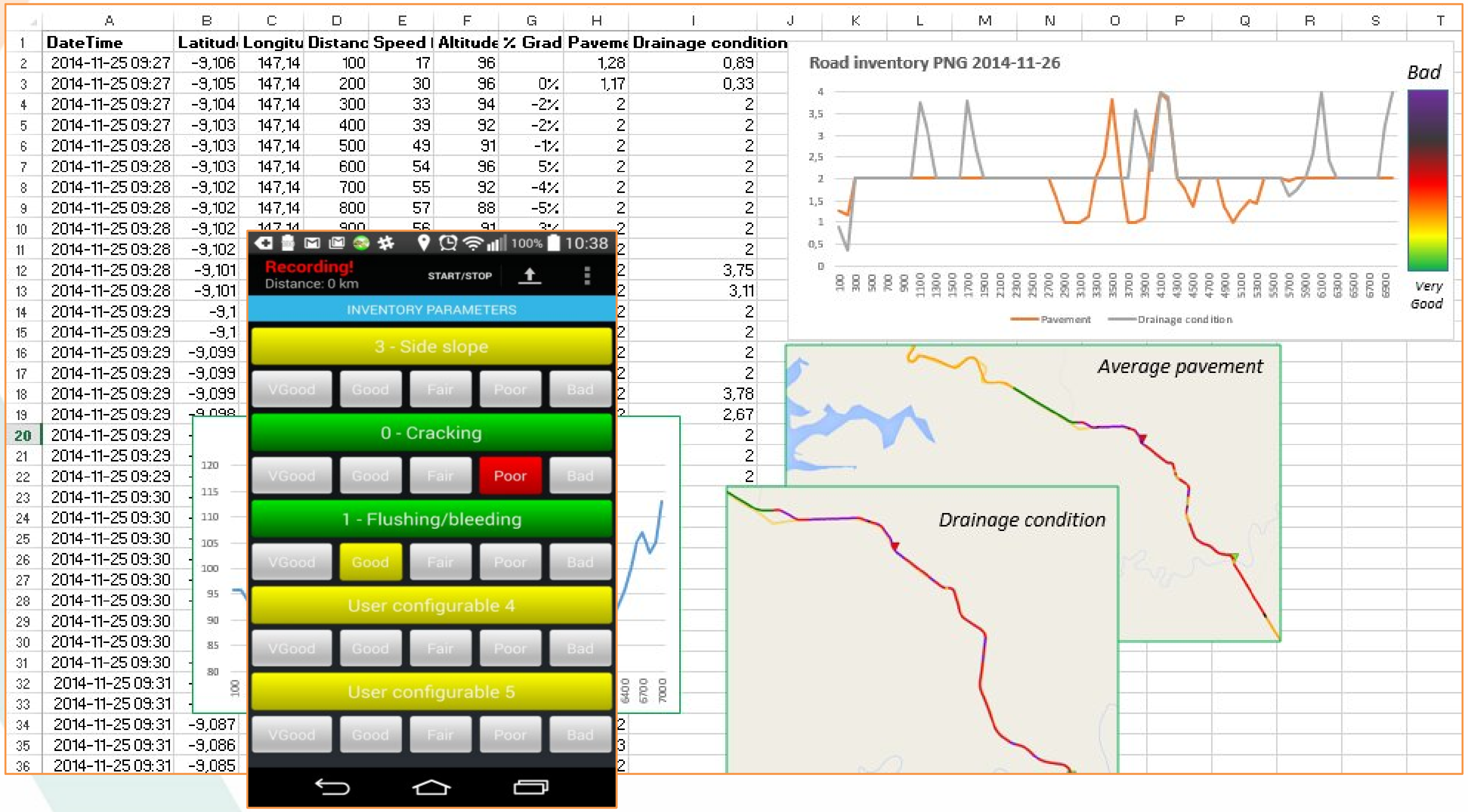
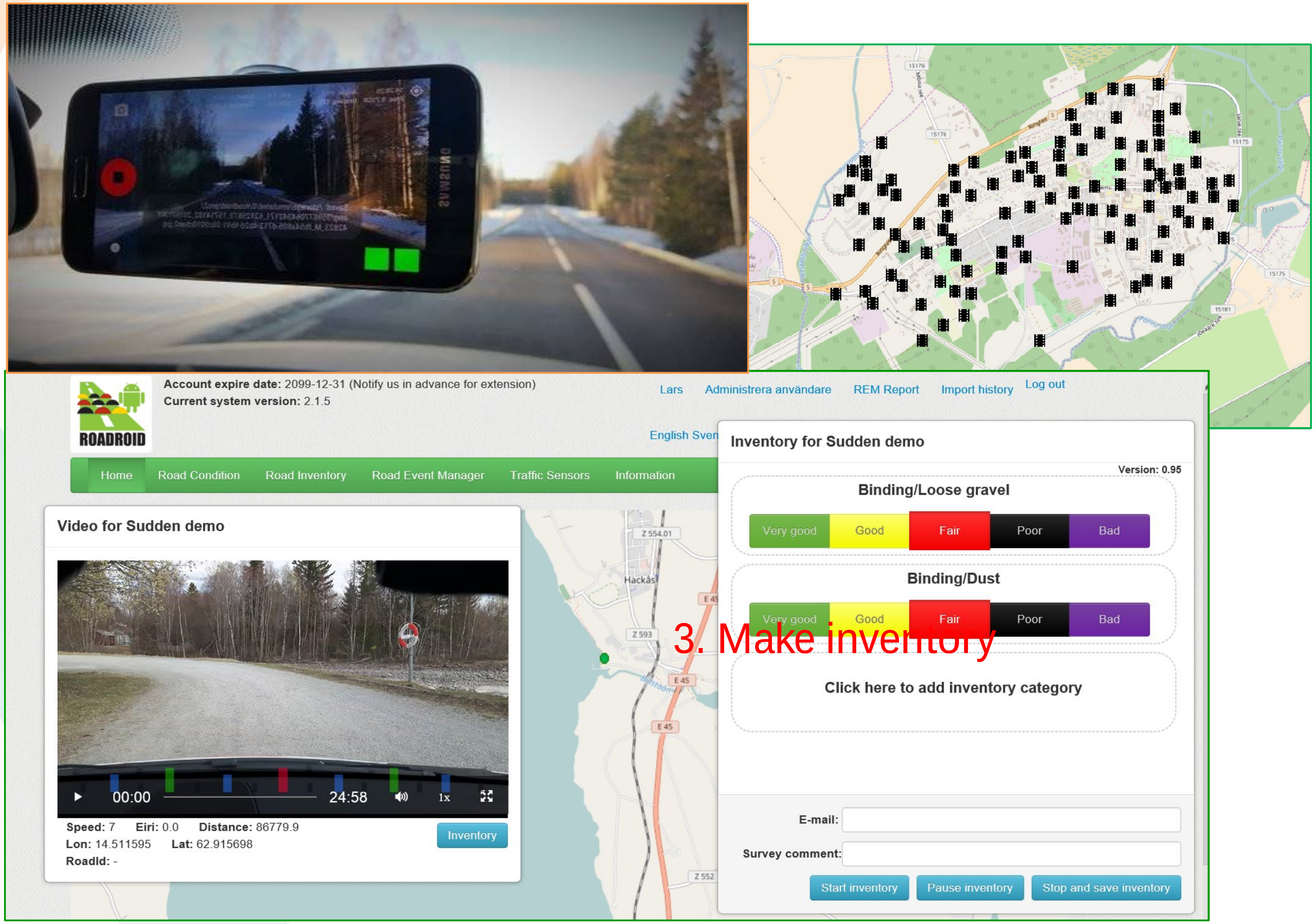


Photo Inventory

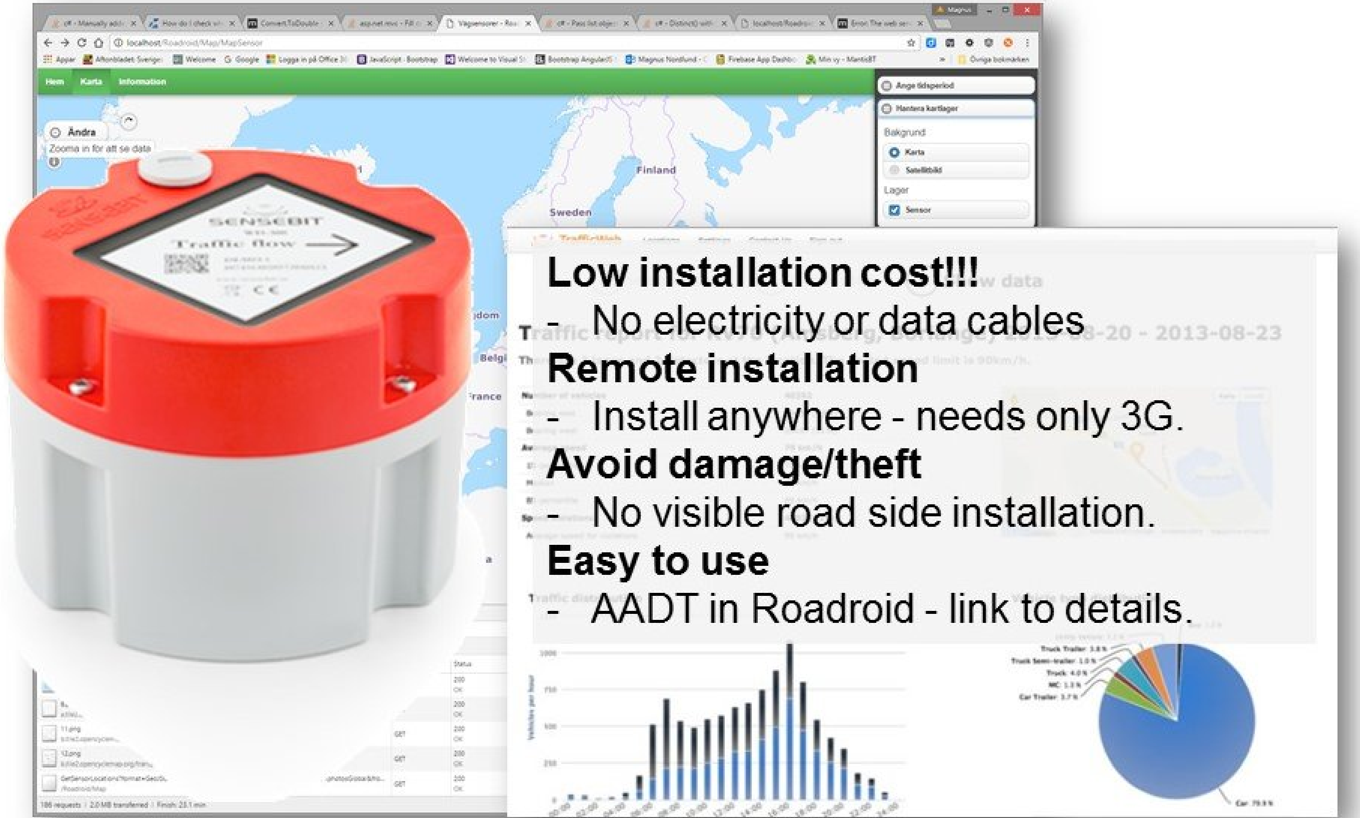
Capture Video:
– make inventory in office



App for traffic counting

- Traffic count app for visual input. Replace pen and paper where sensors can’t be used.
- Easier e than pen and paper, instant presentation no interpretation of hand notes.
- User cases to verify and calibrate automatic traffic sensors or temporary checks

Wireless Traffic sensor + Roadroid



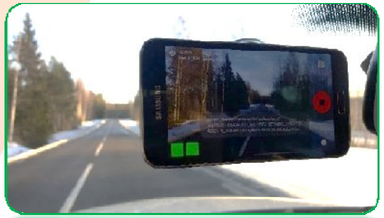
Low installation cost!!!
- No electricity or data cables.

Remote installation
- Install anywhere - needs only 3G.

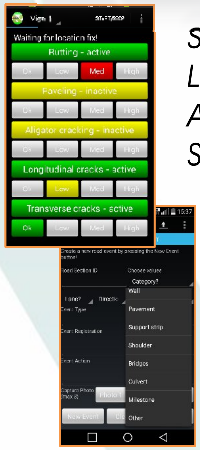
Avoid damage/theft
- No visible road side installation.

Easy to use
- AADT in Roadroid - link to details.

Roadroid gather assets data

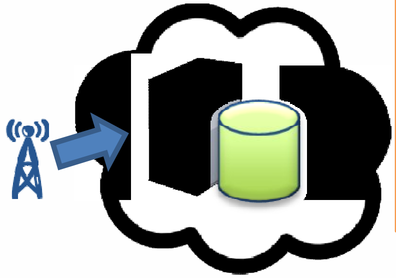


Road condition:
IRI
Photos
Video

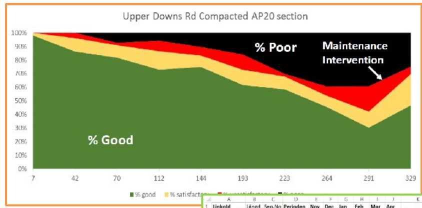


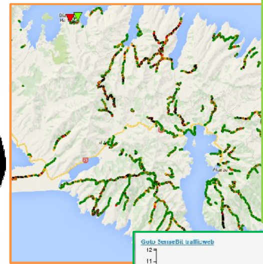
Spatial data:
Longitud/Latitude
Altitude (Grade%)
Speed

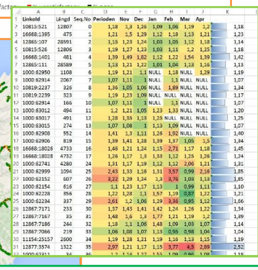
Road inventorys:
Rutting
Edgebreakes,
Drainage
Culverts etc

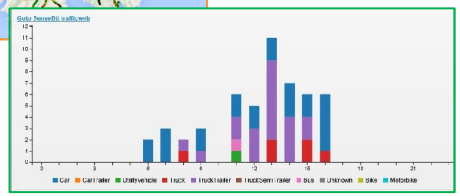


Traffic + temperature







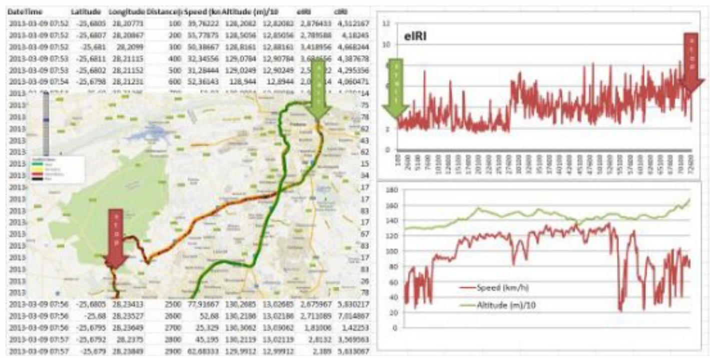


Performance monitoring

- Map overviews
- Tables
- Charts

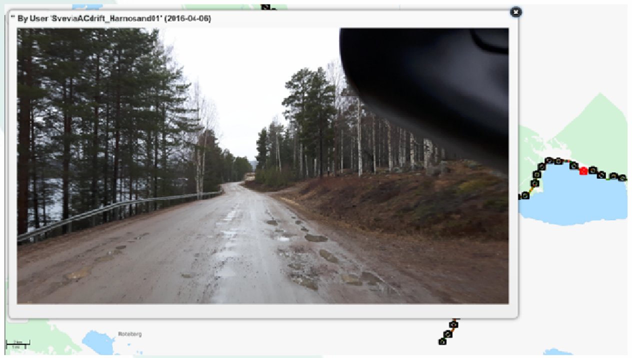
Internet Road Data Management system (RDMS)

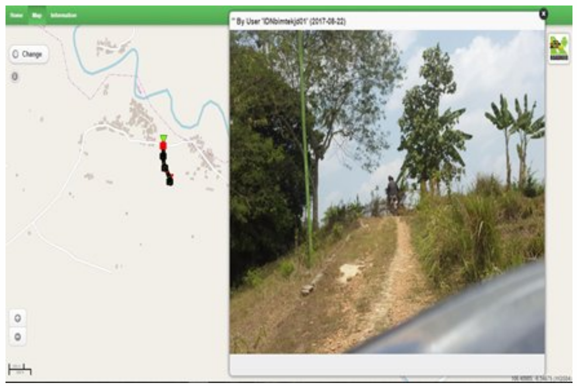
- After the data has been transferred to the cloud service it can be monitored on a map.
- The data is assigned colors depending on the road condition. From green for good to Black for Poor.
- You can extract data in preferred segments (100 meter default) and import them to your assets management system or HDM4.



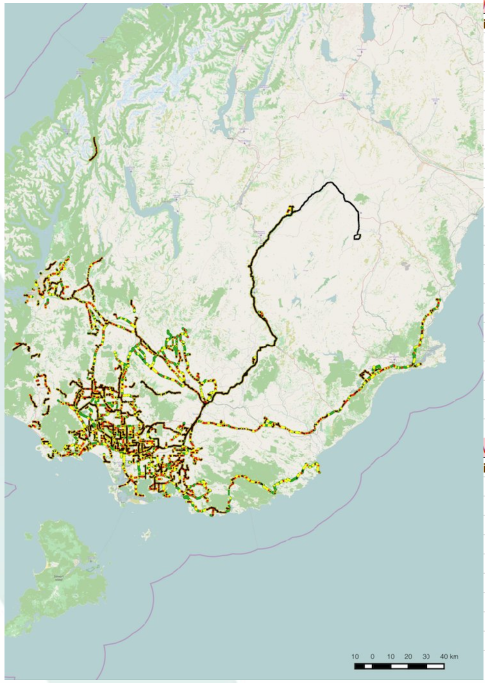
Case studies

- New Zealand
- Sweden – low volume gravel road
- (Afghanistan)
- (Myanmar)
- Indonesia – rural roads





New Zealand



WORST ROUGHNESS (eIRI >2,5)

inkid	CW No	Road Name	Start	End	SpeedNov	SpeedDec	Speed change	avgEiriNov	avgEiriDec	Roughness change
2,6E+07	1E+05	EDENDALE WYNDHAM RD	3031	3649	84	89	6%	2,3	4,5	-49%
2,6E+07	2E+05	HALCROW RD	0	1380	65	81	20%	4,1	4,4	-7%
2,6E+07	1E+06	MORTON MAINS KAMAHI RD	244	2480	77	74	-3%	3,9	4,3	-11%
2,6E+07	2E+05	GROVE BUSH WOODLANDS RD	6250	8829	62	62	0%	4,2	3,9	9%
2,6E+07	1E+05	LOWE RD	0	1346	29	30	6%	4,6	3,8	21%
2,6E+07	1E+05	FERRY RD 1	0	36	20	20	3%	3,9	3,8	4%
2,6E+07	1E+05	HANSON RD	5705	8521	81	43	-86%	1,6	3,6	-56%
2,6E+07	2E+05	BRYDONE GLENCOE RD	14777	16450	89	85	-5%	2,8	3,3	-15%
2,6E+07	2E+05	GROVE BUSH WOODLANDS RD	5122	6250	55	58	5%	2,2	3,1	-30%
2,6E+07	1E+05	ISLAND EDENDALE RD	3505	6713	28	24	-16%	2,3	3,0	-22%
2,6E+07	1E+06	WAIHOPAI DOWNS RD	26	3619	85	59	-43%	2,2	3,0	-27%
2,6E+07	1E+05	RIMU SEAWARD DOWNS RD	10241	13228	64	82	23%	2,6	2,9	-10%
2,6E+07	2E+05	TUSSOCK CREEK GROVE BUSH RD	0	3761	66	73	9%	2,7	2,9	-6%
2,6E+07	1E+05	MATAURA ISLAND FORTROSE RD	8608	11302	88	89	1%	3,2	2,9	11%
2,6E+07	2E+05	WOODSTOCK RD	2940	4304	89	89	0%	2,9	2,9	1%
2,6E+07	2E+05	COUNSELL RD	3222	5651	70	90	22%	4,9	2,9	70%
2,6E+07	2E+05	MABEL WOODSTOCK RD	0	3096	54	54	-1%	2,6	2,7	-3%
2,6E+07	2E+05	RAKAHOUKA HEDGEHOPE RD	6329	7952	47	40	-16%	2,5	2,7	-7%
2,6E+07	1E+05	WALKER RD 1	3240	5334	51	52	3%	2,2	2,7	-18%
2,6E+07	1E+05	SEAWARD RD	0	120	27	25	-9%	3,0	2,6	14%

MOST ROUGHNESS CHANGE (>10% drop)

inkid	CW No	Road Name	Start	End	SpeedNov	SpeedDec	Speed change	avgEiriNov	avgEiriDec	Roughness change
2,6E+07	1E+05	HANSON RD	5705	8521	81	43	-86%	1,6	3,6	-56%
2,6E+07	1E+05	EDENDALE WYNDHAM RD	3031	3649	84	89	6%	2,3	4,5	-49%
2,6E+07	2E+05	BRYDONE GLENCOE RD	9303	11675	56	56	-1%	1,7	2,4	-30%
2,6E+07	2E+05	GROVE BUSH WOODLANDS RD	5122	6250	55	58	5%	2,2	3,1	-30%
2,6E+07	1E+06	WAIHOPAI DOWNS RD	26	3619	85	59	-43%	2,2	3,0	-27%
2,6E+07	1E+05	NIAGARA TOKANUI HWY	16073	18214	42	29	-45%	1,3	1,8	-26%
2,6E+07	2E+05	BRYDONE GLENCOE RD	2882	4187	80	78	-2%	1,5	2,0	-24%
2,6E+07	1E+05	ISLAND EDENDALE RD	3505	6713	28	24	-16%	2,3	3,0	-22%
2,6E+07	1E+05	RIMU SEAWARD DOWNS RD	0	2539	16	49	68%	2,0	2,4	-19%

Sweden – gravel road

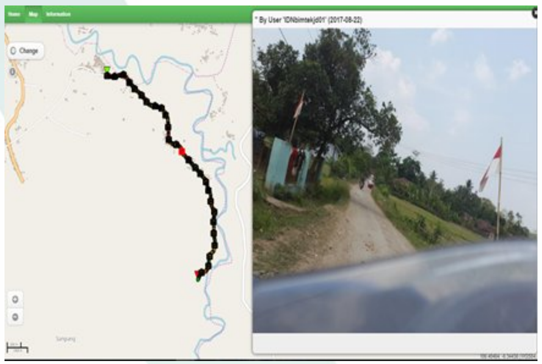
- During 2016/2017, Roadroid has carried out a daily survey of a low-volume gravel road in central Sweden
- to monitor the variance of road condition during the whole year period and also to assess the season effect on the road network.
- The same road is surveyed everyday by a postman vehicle.
- Within the survey, external factor i.e. temperature and traffic count is also taken into account.
- Moreover, a manual general assessment of the road i.e. road condition, potholes on the road, etc. is obtained by the surveyor too.

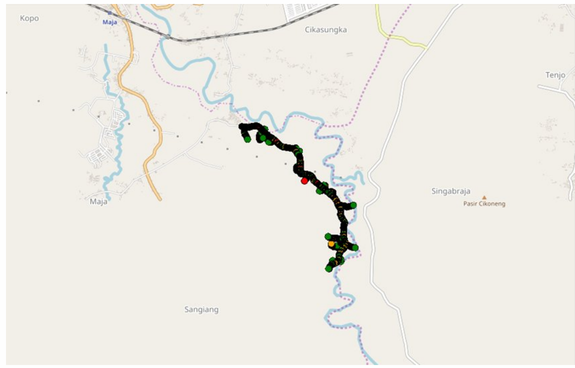
Sweden continued

- The results are satisfactory.
- The output on the collected data by the Roadroid app well corresponds to the manual assessments and effects of external factors.
- Will help the road agencies to understand the seasonal and external factors effects on the road quality which will play a vital role while taking decisions on maintenance, sanctioning rules and regulations and safety measures.

Indonesia – rural road

- A survey was done in Tanjung Sari Village, Banten Province in August 2017
- The survey covered 6,400 meter of road (around 80% of total rural road length) <u>using motorcycle as the vehicle</u>. Time needed to complete this survey is only 2 hour using one motorcycle.



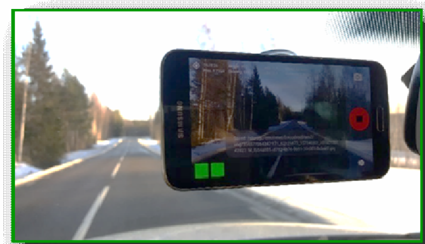


Indonesia continued

- In conclusion, Roadroid could be an alternative for Village Government to manage their rural road conditions.
- The data acquired by Roadroid are IRI, road network maps, and road documentation.
- These data can be used for road asset management and road planning and programming.
- Roadroid would be an optimal tool to do road condition survey in villages with limited budget, allowing it to focus on another aspect of village development without ignoring its road infrastructure quality.

Final conclusions

- Measuring roads with smartphones can provide an efficient, scalable, and cost-effective way to deliver road condition data.
- Results shows that Roadroid has universal usage; but with a specific potential on Low-volume/Low Cost Roads (Rural Roads).
- Smartphone based gathering of roughness data and Road Inventory can be done at a low cost and monitor changes on a daily basis/real time.
- It can also be used in the winter to determine the performance of snow-removal and ice-grading.
- It may be advantageously used in performance based contracts or research on road deterioration, various environmental effects (as heavy rains, flooding, etc.) and other adjacent purposes.
- The system is easily accessible with easy to use technologies and devices and doesn't require professional expertise to operate and carry-out a survey.



Thank you for listening!

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AWARDS:

International Road Federation – Global Road Achivement Award 2014

UN World Summit Award – Global Champion 2013

European Satelite Navigation Competition 2012

USERS:

Road authorities & companies in 20+ countries