



**CROSS/
ROADS**
LINKING MOBILITY SOLUTIONS



IRF WORLD ROAD MEETING 2017

/ 14-17 NOVEMBER / DELHI / INDIA /

**Using high-tech solutions and
remote sensing to increase
knowledge on the extent and
condition of rural road
networks**

Robin Workman
Principal International Consultant
TRL
rworkman@trl.co.uk



AIRBUS DEFENCE AND SPACE

Background: What is the Problem?

- Limited data available on rural road networks
- Lack of resources to update and extend this information
- Terrain and conflict make areas inaccessible to survey
- Lack of information makes planning and prioritisation of maintenance difficult
- Leads to restricted access and ultimately affects poverty

Potential solutions

- Satellite applications
- Pseudo satellites
- UAVs
- High definition video
- Smartphone applications

Potential benefits of remote sensing?

- Rapid assessment over large areas
- Logistically easier
- Can provide a permanent visual record of the assessment
- Can be used for other purposes
- Safer, avoids the need to visit areas in conflict

Road condition from satellite imagery

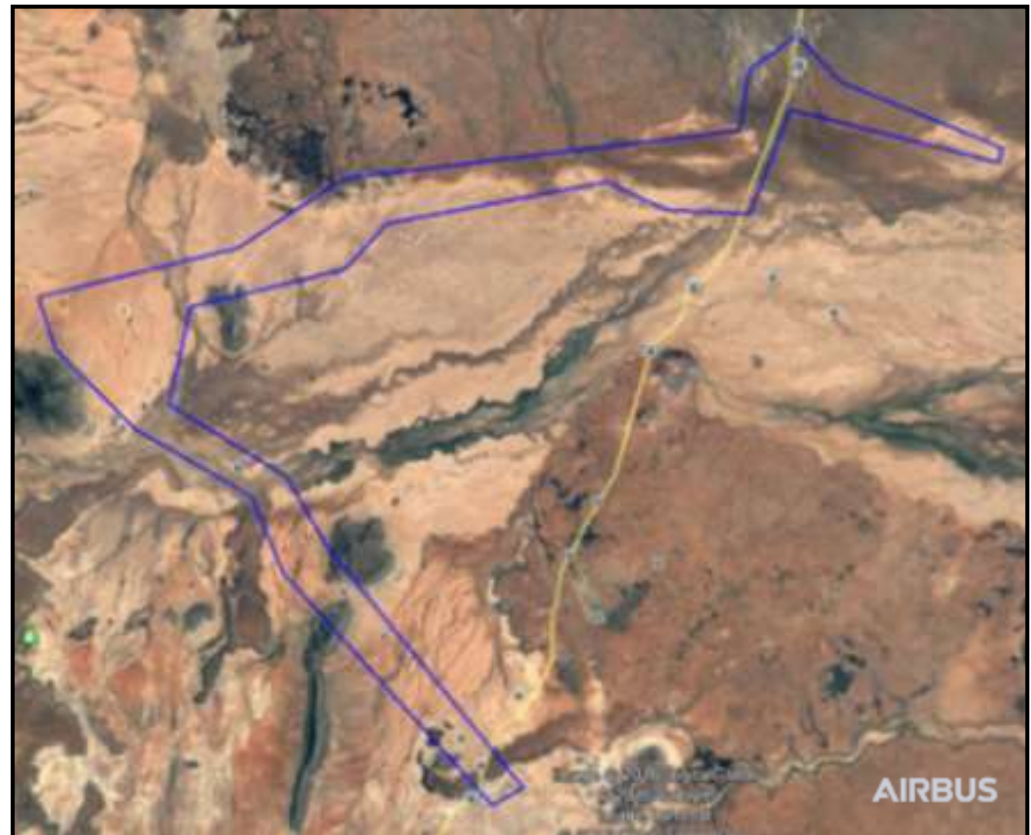
- Original pilot in Nigeria, to test with conflict and inaccessibility
- Rural, unpaved roads
- Successful enough to warrant further research
- DFID funded research under AfCAP in Ghana, Kenya, Tanzania, Uganda and Zambia

Develop a Methodology

- Define an Area of Interest
- Carry out Ground Truthing
- Imagery Acquisition
- Train in software and image interpretation
- Mapping and Inventory
- Calibration
- Satellite imagery assessment

Define an Area of Interest (Aoi)

- Select an area with a range of conditions
- Avoid areas with no roads



Carry out Ground Truthing

- Use existing system and methods of condition assessment:
 - Visual assessment
 - Speed
 - Roughometer
 - Smartphone app: RoadLab
 - HD video cameras

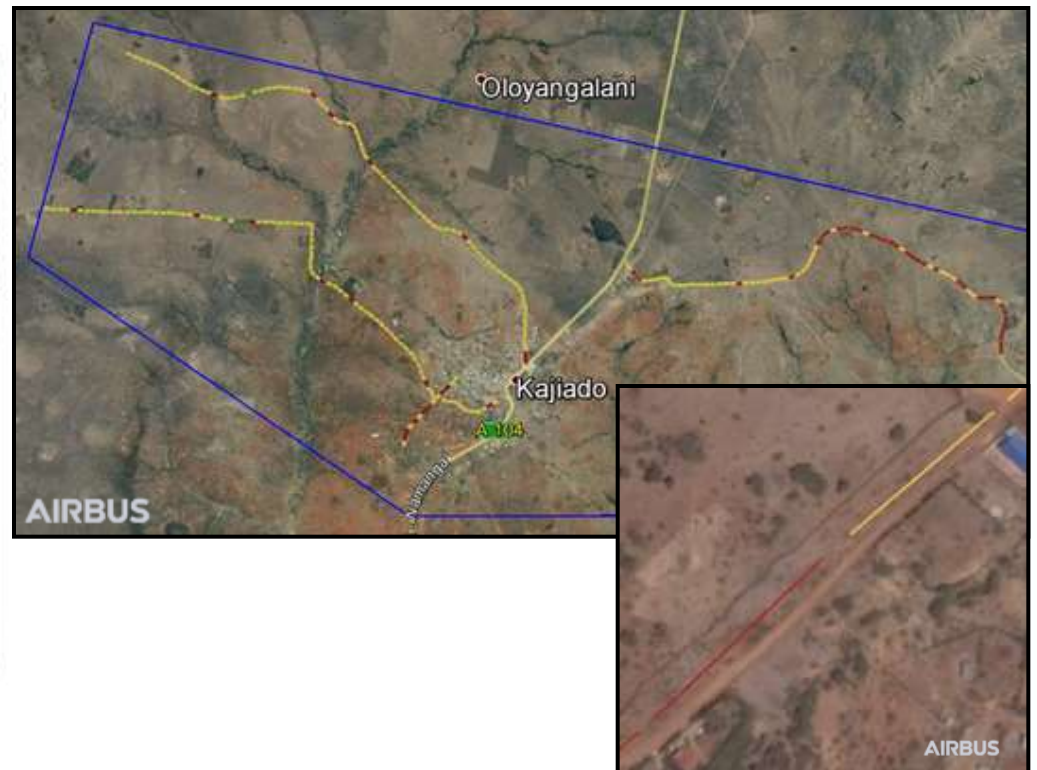
Ground Truthing

- Speed - World Bank Scale;

Condition rating (WB rating)	Typical Speeds achieved in km/h on an unpaved road
Very Good (Excellent)	80-100
Good (Good)	70-80
Fair (Fair)	40-70
Poor (Poor)	30-40
Very Poor (None)	<30

Ground Truthing

- Roughometer: Less accurate at low speeds on poor roads
- RoadLab: Smartphone App for IRI measurement



Carry out Ground Truthing

- HD Video cameras with GPS: DashCam



Imagery Acquisition

- Very High Resolution imagery < 0.5m
 - Pleiades 0.5m resolution
 - WorldView 0.5m and 0.3m resolution



Software and Training

- GIS software = QGIS: Freely available, so sustainable
- Involve local remote sensing organisations
- Produce training materials



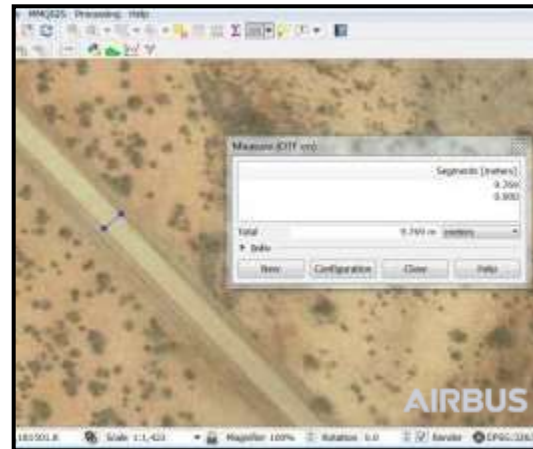
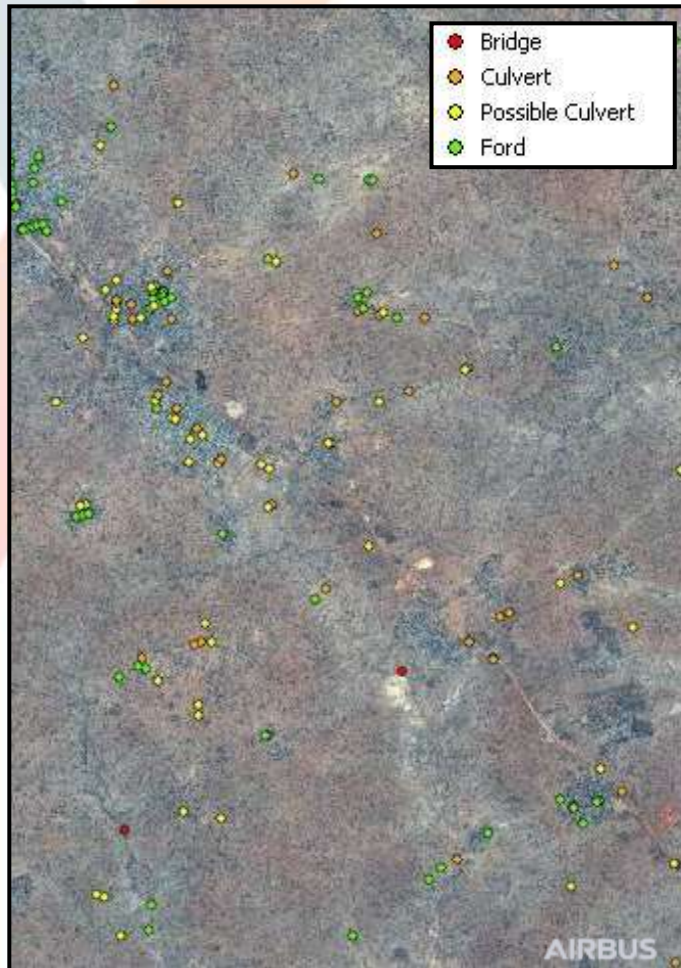
Mapping

- Digitise centre lines as accurately as possible





Inventory

- Locate inventory where possible



Calibration to local conditions

- Produce a calibration guide

Description	Example
<p data-bbox="483 446 647 475">Good (Green):</p> <p data-bbox="483 535 879 628">Some slight differences in surface colour and texture can be seen, but generally very even.</p> <p data-bbox="483 642 879 706">Negligible or slight variation in width, up to 10%.</p> <p data-bbox="483 721 879 813">Edge of road consistent and straight, but may vary slightly in isolated areas.</p> <p data-bbox="483 828 724 856">See Figures 1.1 to 1.5.</p> <p data-bbox="483 871 879 1092">Condition can be relative for earth and gravel roads. If the surface can be determined, the condition of earth roads can be shown as good when the width and edges vary slightly and some surface irregularities can be seen.</p> <p data-bbox="483 1106 879 1270">For unpaved roads this category will normally apply to recently constructed or rehabilitated roads, or roads that have received regular maintenance and grading.</p>	<p data-bbox="904 446 1477 506">Figure 1.1 Newly rehabilitated road, hence light coloured gravel, straight edges</p>  <p data-bbox="917 796 1120 813">© Airbus Defence and Space</p> <p data-bbox="904 835 1362 863">Figure 1.2 Well maintained road in populated area</p>  <p data-bbox="917 1325 1120 1342">© Airbus Defence and Space</p>

Assessment of Condition

- Identify features that indicate long-term condition:
 - Change in width of the road
 - Straightness and integrity of road edges
 - Surface texture/shading/hue
 - Surface colour
 - Shadow
 - Patterns in surface, wheel tracking if visible

Assessment of Condition



Assessment of Condition

- Three to five level assessment

Very Good	Good	Fair	Poor	Very Poor	Unknown
Dark Green	Light Green	Yellow	Amber	Red	Blue

Good	Fair	Poor	Unknown
Light Green	Yellow	Red	Blue

Ground Truthing

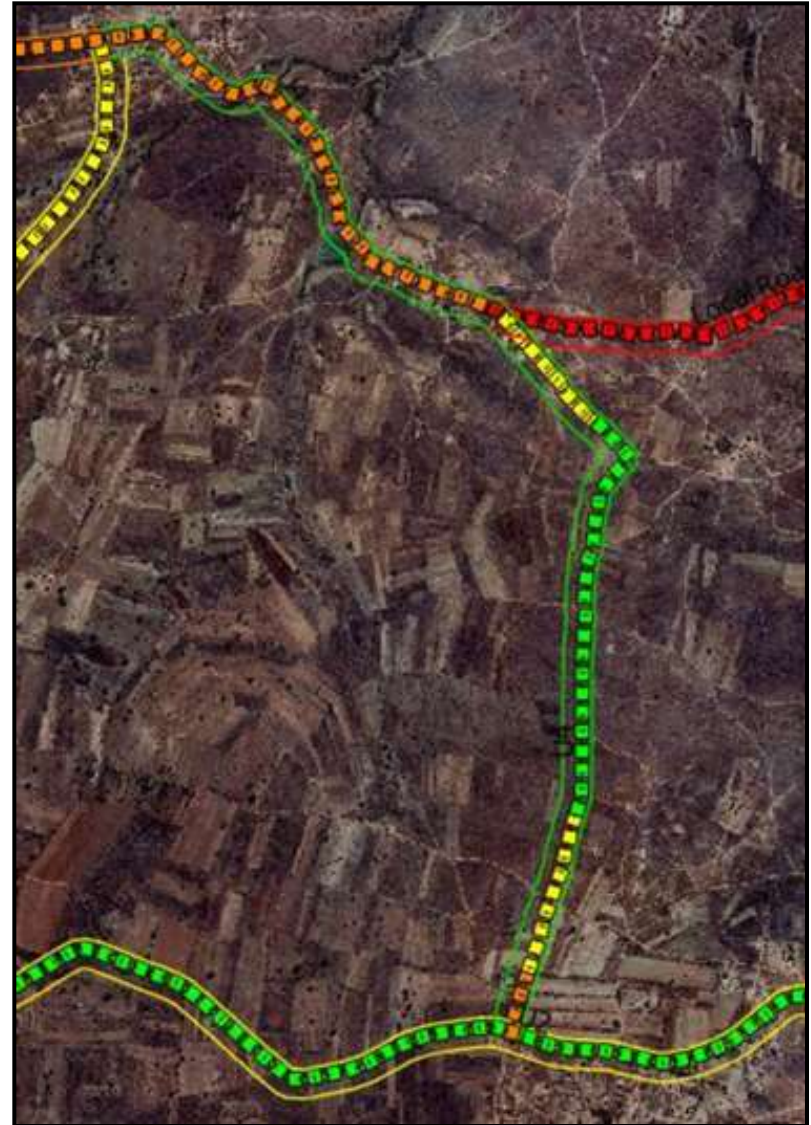


Condition Assessment



Assessment of Condition

- Compare the ground truthing to the condition assessment results
- Analyse results

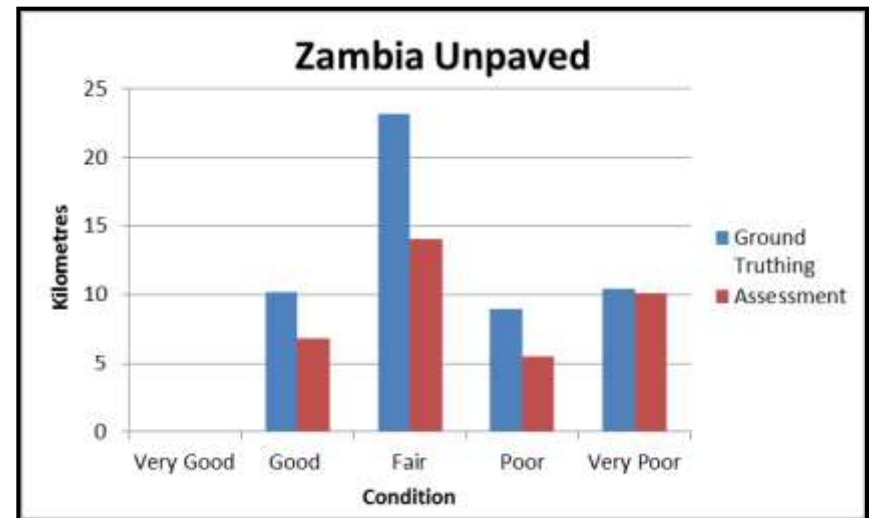
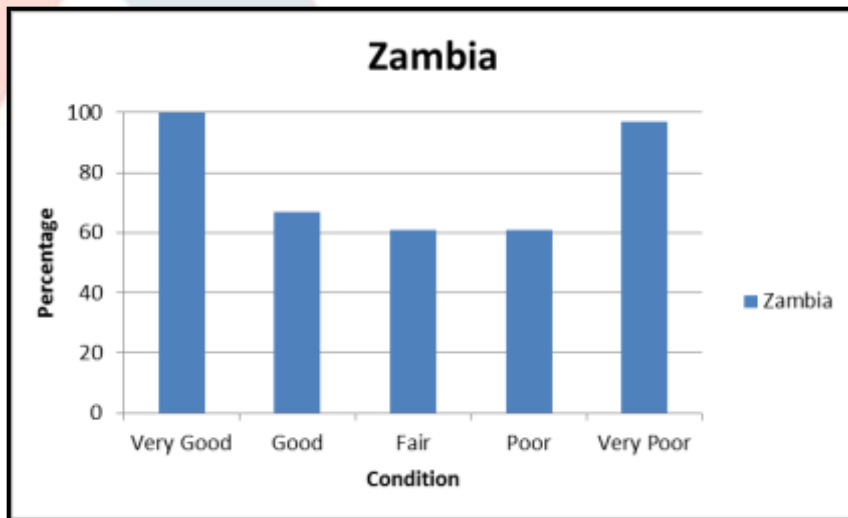


Zambia

Assessment			Misclassified as;					
	Ground truthing (km)	Corresponding Satellite assessment (km)	V.Good	Good	Fair	Poor	V.Poor	Unknown
V Good	0	0						
Good	10.191	6.829			1.139	2.223		
Fair	23.153	14.087		6.835		2.231		
Poor	8.973	5.514			3.459			
V Poor	10.402	10.129				0.273		
	52.719	36.559						

Correlation			Percentage of correctness
V Good	0.00	0.00	100%
Good	10.191	6.829	67%
Fair	23.153	14.087	61%
Poor	8.973	5.514	61%
V Poor	10.402	10.129	97%
	52.72	36.56	69%

Misclassified as more than one level out:
2.223 4.22% > 1 level out

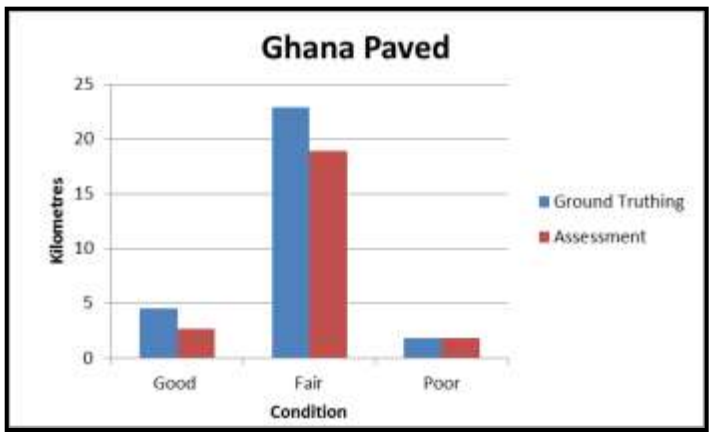
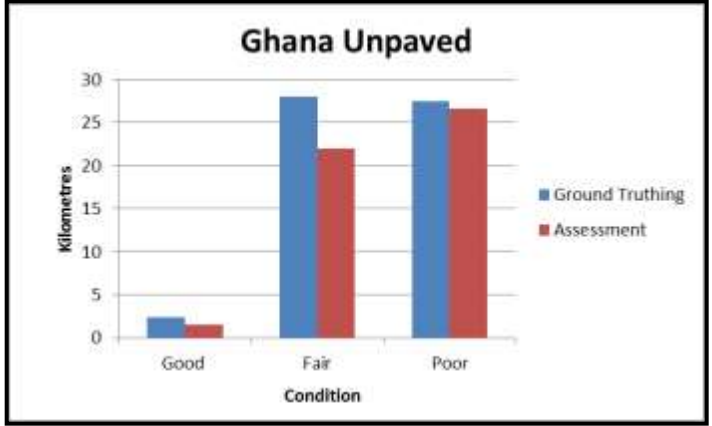
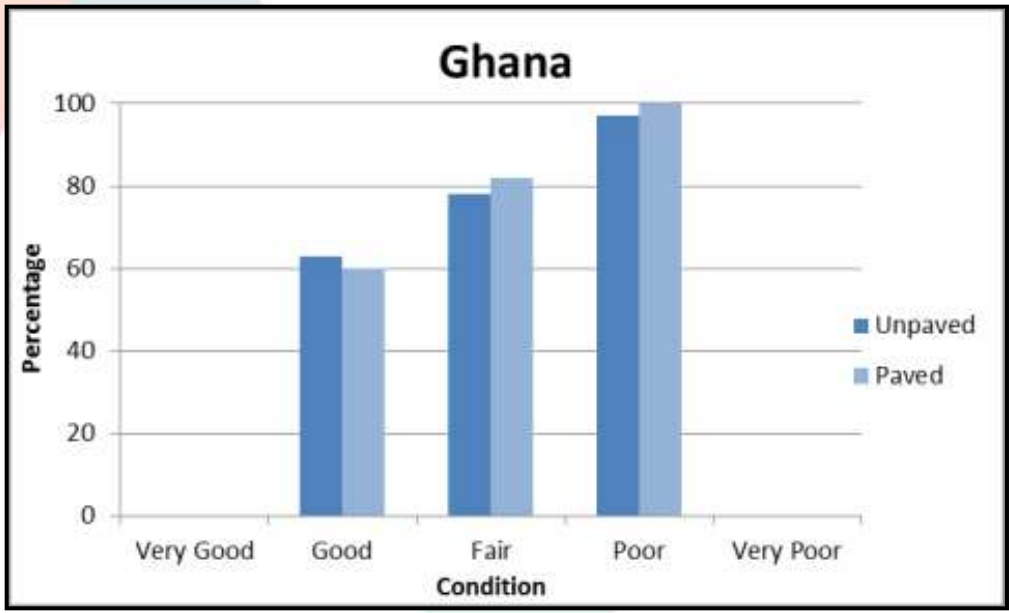


PAVED Assessment			Misclassified as;				
	Ground truthing (km)	Corresponding Satellite assessment (km)	Good	Fair	Poor		Unknown
Good	4.527	2.716		1.693	0.118		0
Fair	22.934	18.918	3.467		0.549		0
Poor	1.845	1.845					0
	29.306	23.479					

	Correlation		Percentage of correctness
Good	4.527	2.716	60%
Fair	22.934	18.918	82%
Poor	1.845	1.845	100%
	29.306	23.479	80%

Misclassified as more than one level out:
 0.118 0.40% > 1 level out

Ghana



Cost Effectiveness

- Figures based on country estimates
- Discounts available for imagery
- Less environmentally damaging
- Good for inaccessible areas

Country Details		Network Details	Satellite assessment per km this project	Satellite assessment per km headline prices	Traditional condition assessment per km
			£	£	£
Ghana					
Length of road km	37.562				
Square area km ²	153		22.65	67.12	21.30
Road Density km/km ²	0.25				
Imagery cost £	590.75				
Kenya					
Length of road km	77.882				
Square area km ²	288		30.56	58.40	21.40
Road Density km/km ²	0.27				
Imagery cost £	2088				
Uganda					
Length of road km	145.715				
Square area km ²	187		10.26	23.49	9.22
Road Density km/km ²	0.78				
Imagery cost £	836.46				
Zambia					
Length of road km	52.719				
Square area km ²	119		30.62	40.24	30.00
Road Density km/km ²	0.44				
Imagery cost £	1251.52				

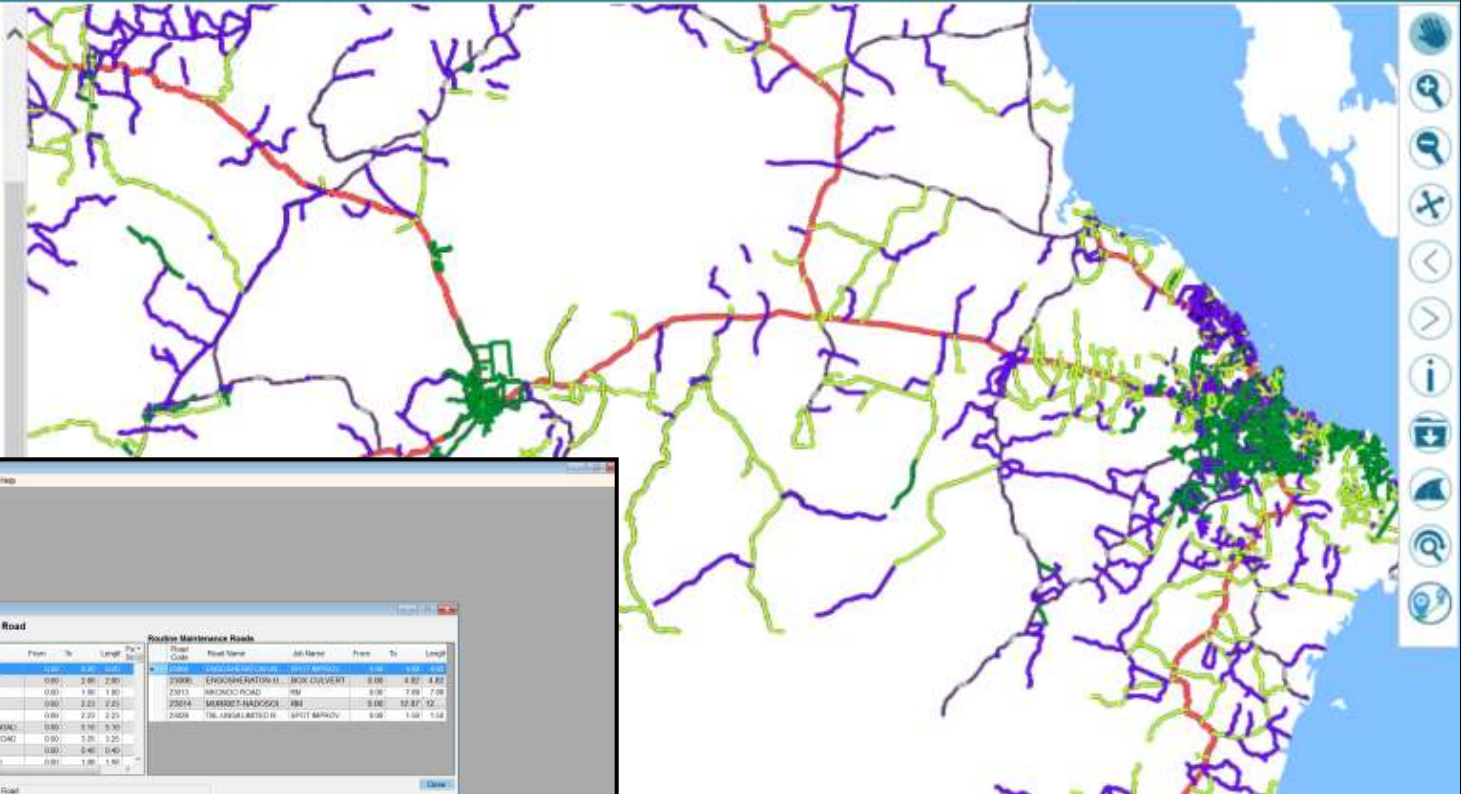
Incorporation into a RAMS database

- Nigeria: iROADS, Tanzania: DROMAS

District Road Management System: Map - 2016/17

2016/17

- Bing Road
- Bing Aerial
- Tanzania Basemap**
 - District
 - Region
 - Ward
 - Major River
 - Railway
 - Regional Roads and Trunk Roads
 - Water Body
- Road Network**
 - Road Network
 - Road Links
 - Road Nodes



ADMIN - Road Network - AMM - Contract Management - Cost System - Map - Help

ROUTINE MAINTENANCE ROAD SELECT

ROUTINE MAINTENANCE: Select Road

District Roads						Routine Maintenance Roads					
Road Code	Road Name	From	To	Length (Km)	Pa (%)	Road Code	Road Name	Ad. Name	From	To	Length (Km)
22001	MBINDI-CHINDI RD	0.00	2.80	2.80		22006	ENHANGU NATIONAL PARK CULVERT		8.00	4.80	4.80
22003	SP. CHAP. JARDI RD	0.00	1.80	1.80		22013	MANICHO ROAD	RM	8.00	7.00	7.00
22004	NYISORE RD	0.00	2.00	2.00		22014	MARIBET-NADOSOGI	RM	0.00	12.87	12.87
22005	SHOKORE ROAD	0.00	2.20	2.20		22024	TIL. ANJAL. ANTO. D. B.	SP. RT. MAR. OV.	0.00	1.00	1.00
22006	SHINDI-MENYATI ROAD	0.00	2.90	2.90							
22007	SISSO-ONKEDI ROAD	0.00	3.20	3.20							
22008	CHIBE ROAD	0.00	0.40	0.40							
22009	MAB. F. TIL. ANJ. ANTO. D. B.	0.00	1.00	1.00							

Road Code: _____ Name of Road: _____

Work Desc: _____

Work From: _____ Work To: _____

Log: ROUTE/TRA - District - Anjale DC - Road Net - 2016/17

Conclusions

- Can provide a rapid assessment of large areas
- Not as detailed as traditional systems
- Will need support or partnership with remote sensing organisations in short-medium term
- Flexible enough to calibrate to existing local condition assessment systems
- Process is subjective, but there is scope for developing an automated system

Conclusions

- Results reasonably consistent, show that 3 levels of condition can be assessed more accurately
- More appropriate for unpaved roads, but can be used for paved roads
- Would benefit from embedment in a RAMS
- DashCams cheap and appropriate for ground truthing
- Cost effective if significant discount on imagery
- Optimum solution is likely to be a combination of more than one technology



Thank You

<http://www.research4cap.org/SitePages/SatelliteImagery.aspx>



AIRBUS

DEFENCE AND SPACE