Recent Innovations in the Management of Irish National Roads

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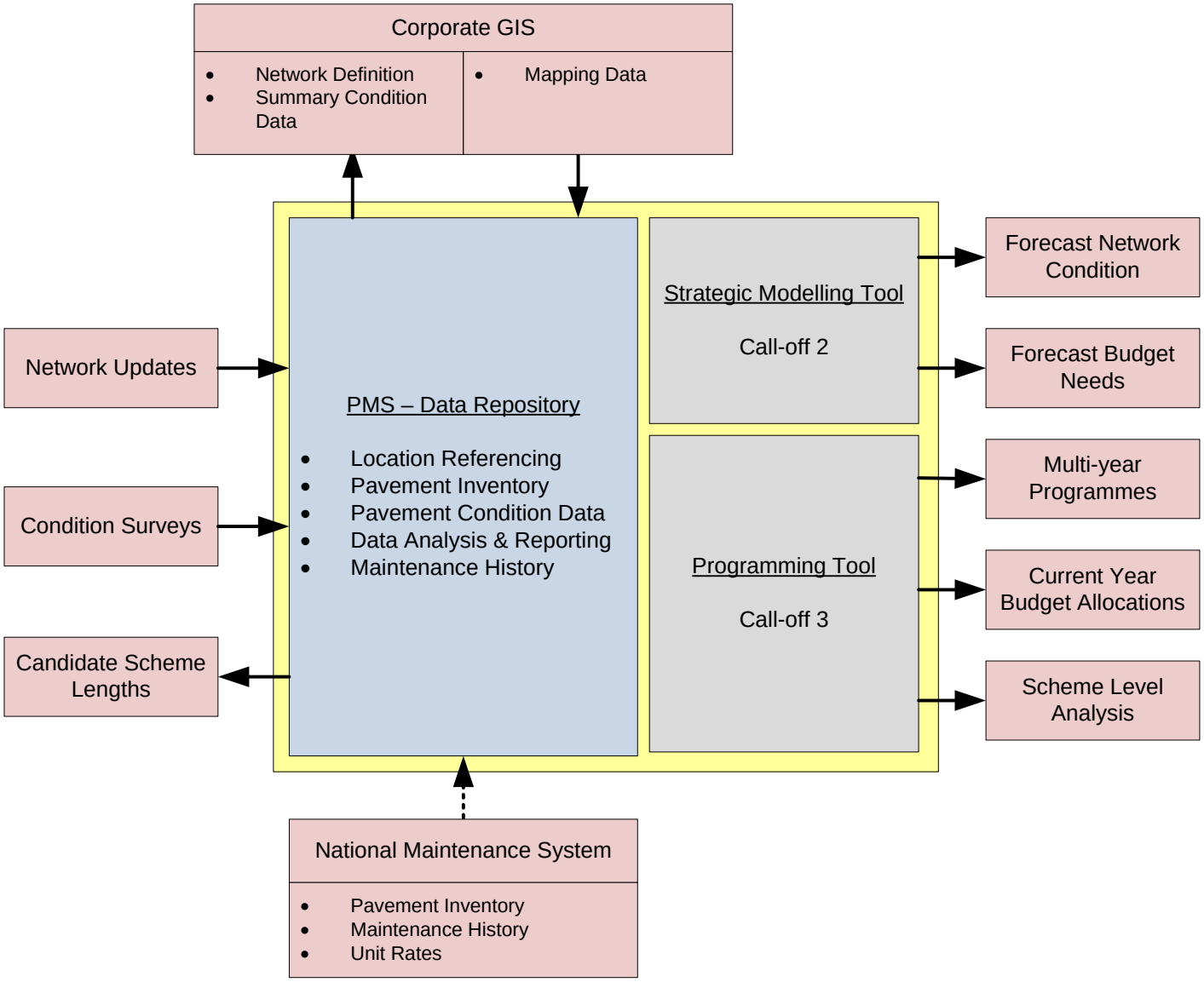
NRA Pavement Management System

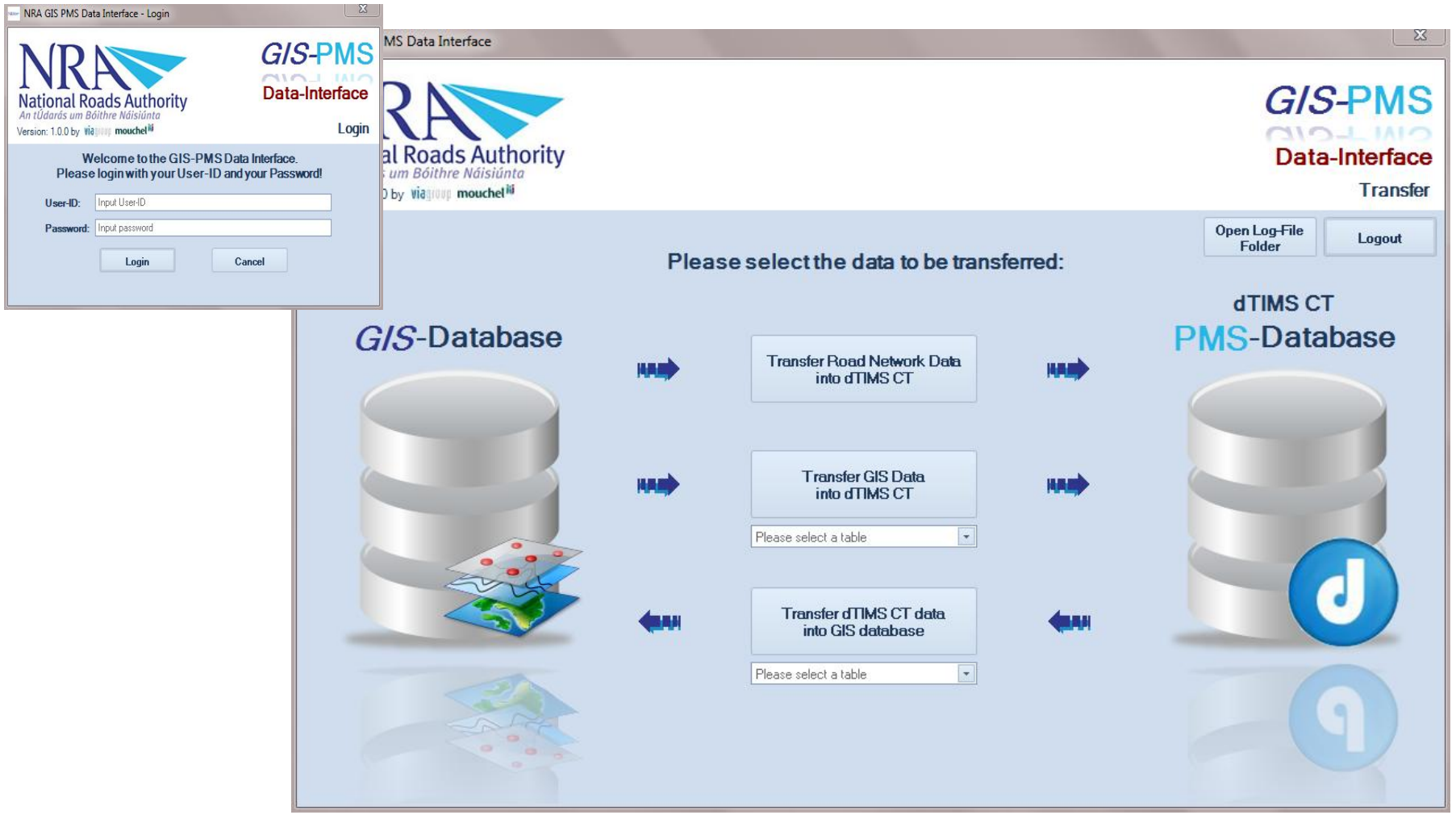
- dTIMS version 8 (now v.9)
- Implemented in 2011/2012 – improvements ongoing
- Data Repository
- Location Referencing System
- Condition Data
- Structure Data
- Age
- Surface Type
- Traffic
- Maintenance History


Corporate GIS
Network Definition
Summary Condition Data
Mapping Data
Network Updates
Condition Surveys
Candidate Scheme Lengths
PMS – Data Repository
Location Referencing
Pavement Inventory
Pavement Condition Data
Data Analysis & Reporting
Maintenance History
Strategic Modelling Tool
Call-off 2
Programming Tool
Call-off 3
Forecast Network Condition
Forecast Budget Needs
Multi-year Programmes
Current Year Budget Allocations
Scheme Level Analysis
National Maintenance System
Pavement Inventory
Maintenance History
Unit Rates

Georeferenced Data

- ESRI ArcGIS is at the centre of all management systems in NRA
- All data collected is georeferenced and mapped to new Location Referencing System (LRS) defined in 2012
- Every video frame is georeferenced, all stored in cloud and on NRA servers (optimised for cloud access)
- Android apps developed for access and portability of video
- Plug-in app for video viewing within ArcGIS

Data-Transfer Tool



PMS Network Surveys

- Full network 1 direction each year
- Skid Resistance
- Ride Quality (IRI)
- Macrotexture
- Rut Depth
- Geometrics
- Video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PMS
PAVEMENT MANAGEMENT SERVICES LTD
VOLVO

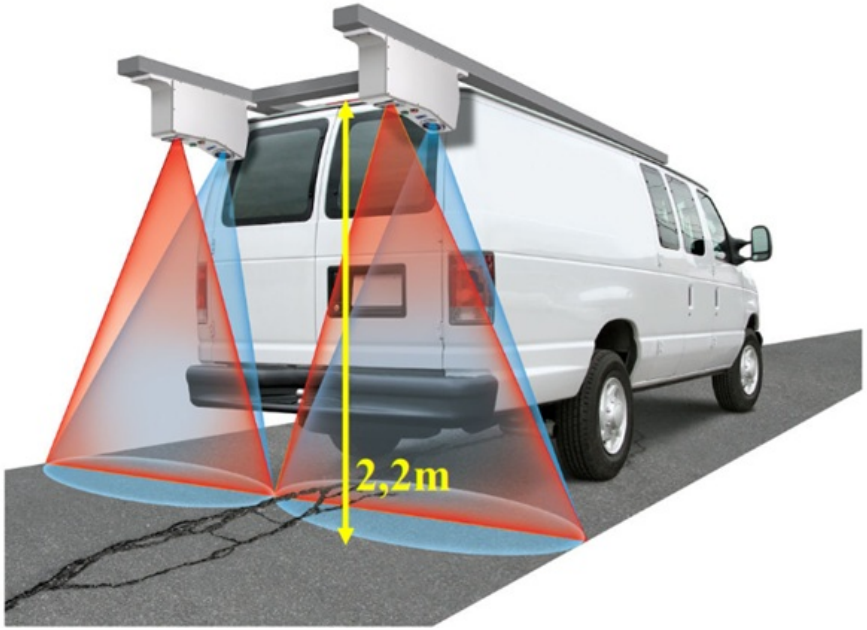
RSP-General View

Network Surveys post 2012

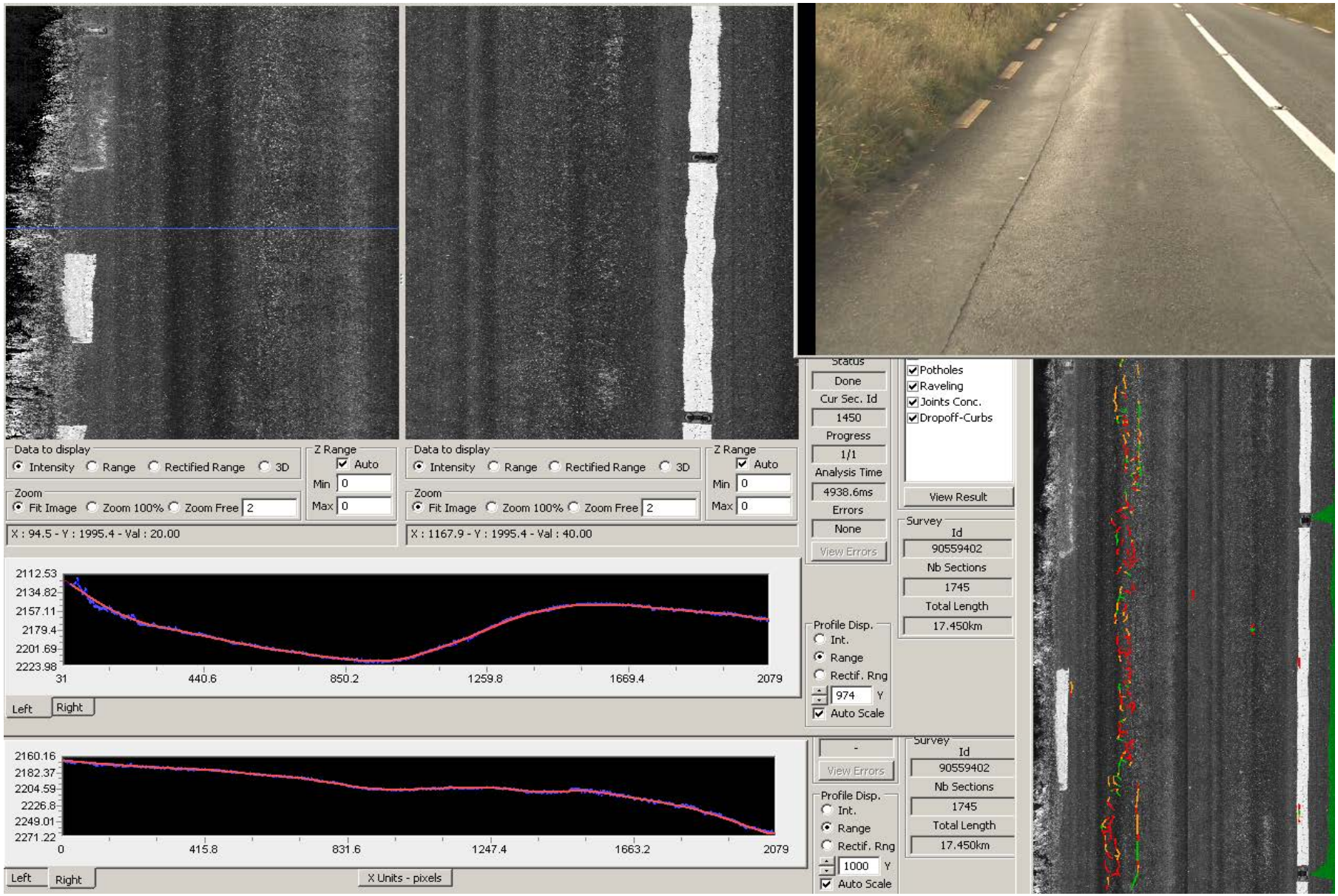
- Crack Detection
- Crack Types and widths
- Ravelling
- Detailed Cross section (4000 points, 1mm accuracy)
- Ground Penetrating Radar (pavement thickness)

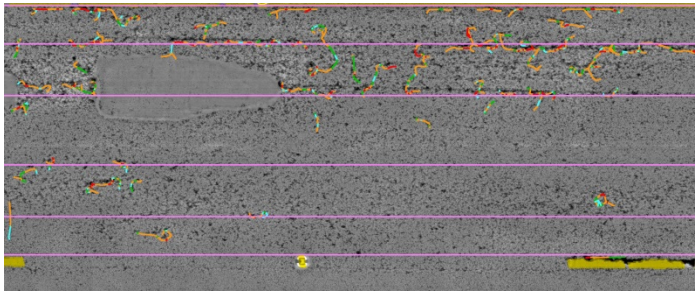
LCMS

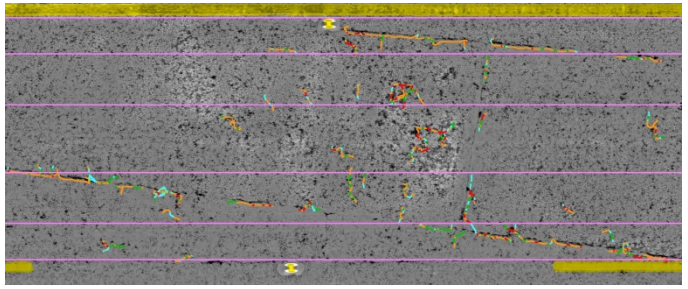
- Laser
- Crack
- Measurement
- System



LCMS


Data to display
Intensity
Range
Rectified Range
3D
Z Range
Auto
Min 0
Max 0
Zoom
Fit Image
Zoom 100%
Zoom Free 2
X : 94.5 - Y : 1995.4 - Val : 20.00
X : 1167.9 - Y : 1995.4 - Val : 40.00
Status
Done
Cur Sec. Id
1450
Progress
1/1
Analysis Time
4938.6ms
Errors
None
View Errors
Potholes
Raveling
Joints Conc.
Dropoff-Curbs
View Result
Survey
Id
90559402
Nb Sections
1745
Total Length
17.450km
Profile Disp.
Int.
Range
Rectif. Rng
974
Y
Auto Scale
2112.53
2134.82
2157.11
2179.4
2201.69
2223.98
31
440.6
850.2
1259.8
1669.4
2079
Left
Right
2160.16
2182.37
2204.59
2226.8
2249.01
2271.22
0
415.8
831.6
1247.4
1663.2
2079
X Units - pixels
1000





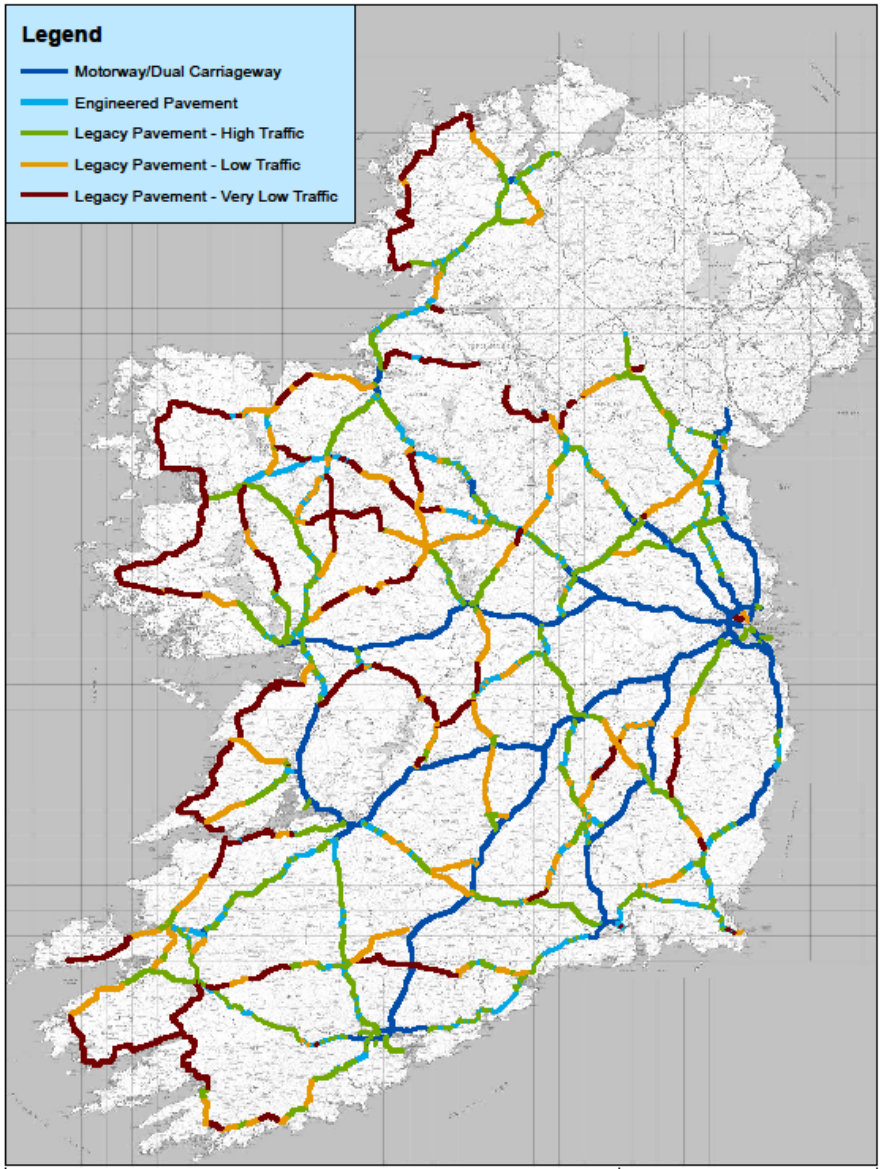
Sub-networks

National network is not homogeneous.

- Ranges from brand new fully engineered motorway to legacy pavements
- Management of the network needs to recognise this variability in order to manage intelligently
- Concept of Sub-networks introduced to address this

Sub-networks

- Network is either Engineered or Non-Engineered/Legacy
- Engineered pavements divided into Motorway/Dual Carriageway or Single Carriageway
- Legacy pavement network divided into High, Moderate and Low traffic



Subnetwork Classification

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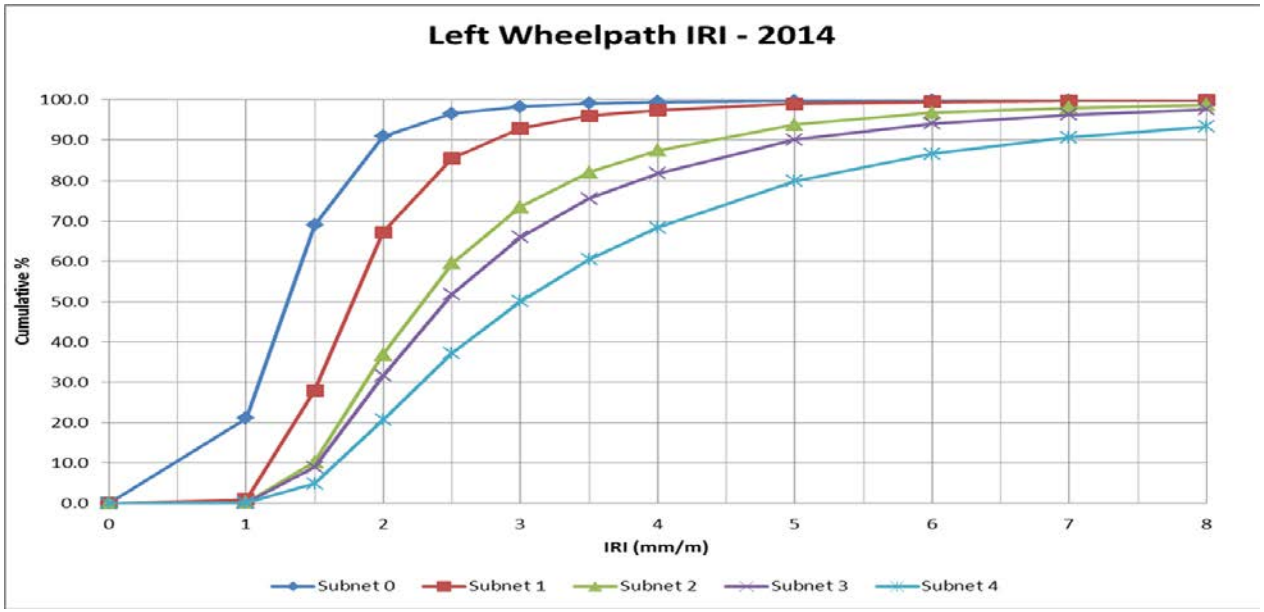
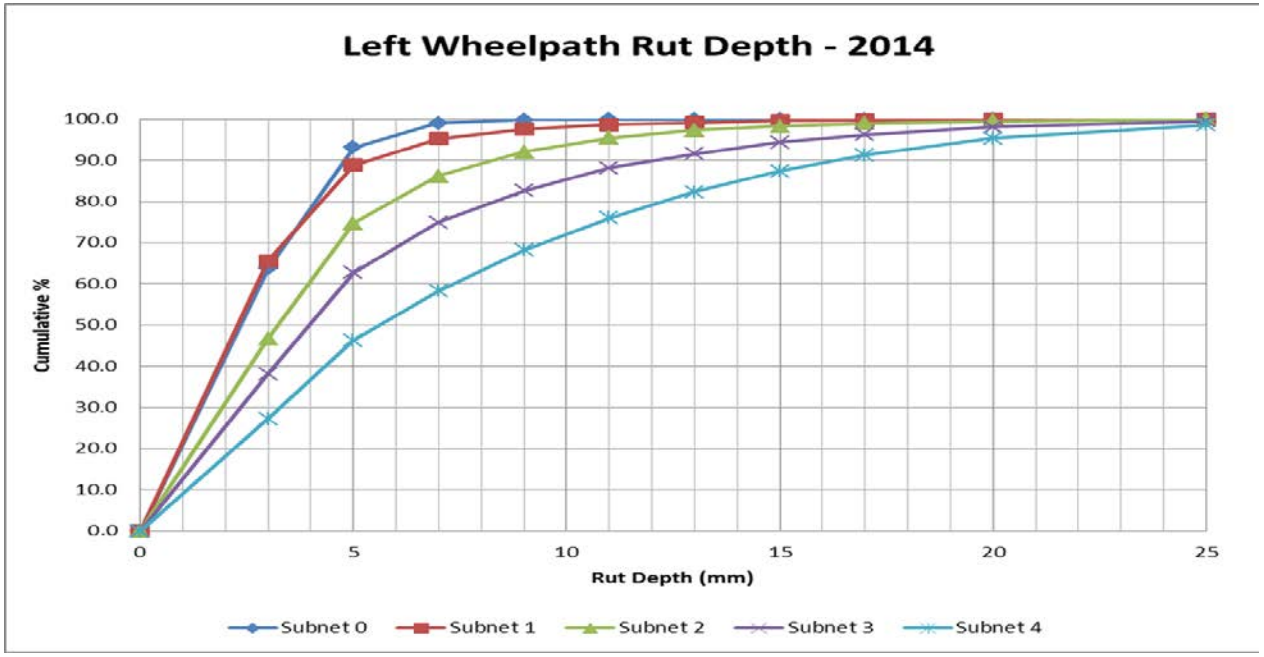

Left Wheelpath IRI - 2014
Cumulative %
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
1
2
3
4
5
6
7
8
IRI (mm/m)
Subnet 0
Subnet 1
Subnet 2
Subnet 3
Subnet 4


Left Wheelpath Rut Depth - 2014
Cumulative %
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
5
10
15
20
25
Rut Depth (mm)
Subnet 0
Subnet 1
Subnet 2
Subnet 3
Subnet 4

Sub-networks – Practical Implications

Different Allowable Levels of service i.e. Different definitions of Very Good/Good/Fair etc

IRI

Category	Subnet 0	Subnet 1	Subnet 2	Subnet 3	Subnet 4
V Poor	>3	>3.5	> 5	> 5	>7
Poor	2.5 to 3	3 to 3.5	4 to 5	4 to 5	5 to 7
fair	2 to 2.5	2.5 to 3	3.2 to 4	3.2 to 4	4 to 5
Good	1.5 to 2	2 to 2.5	2.7 to 3.2	2.7 to 3.2	3 to 4
V. Good	<1.5	<2	<2.7	<2.7	<3

Rut Depth

Category	Subnet 0	Subnet 1	Subnet 2	Subnet 3	Subnet 4
V Poor	>9	>9	> 15	> 15	>20
Poor	6 to 9	6 to 9	9 to 15	9 to 15	15 to 20
fair	5 to 6	5 to 6	6 to 9	6 to 9	9 to 15
Good	3 to 5	3 to 5	4 to 6	4 to 6	6 to 9
V. Good	<3	<3	< 4	< 4	< 6

LPV3

Category	Subnet 0	Subnet 1	Subnet 2	Subnet 3	Subnet 4
V Poor	> 4	> 5	> 6	> 7	> 10
Poor	3 to 4	4 to 5	4 to 6	5 to 7	7 to 10
fair	2 to 3	3 to 4	3 to 4	3.5 to 5	4 to 7
Good	1 to 2	1.5 to 3	2 to 3	2 to 3.5	2 to 4

Sub-networks – Practical Implications

Different deterioration model parameters

$$IRI_t = IRI_{t-1} + (a + b \cdot ESAL_t \cdot 10)$$

	0	1	2	3	4
a	0.05	0.05	0.08	0.11	0.15
b	0.0025	0.005	0.008	0.015	0.02

$$RD_t = A \cdot cumESAL_t^b$$

	0	1	2	3	4
A	2.4	2.75	3.5	5	7
b	0.35	0.4	0.6	0.7	0.8

$$LPV3_t = LPV3_{t-1} + a \cdot ESAL_t$$

	0	1	2	3	4
a	0.02	0.2	0.45	0.88	2

Annual monitoring of overlay scheme locations allow models to be updated to reflect “real” deterioration rates

Sub-networks – Practical Implications

Different trigger values for treatments

- Treatments are triggered on maintenance sections when two or more parameters becomes Poor or Very Poor

Parameter	Subnet 0	Subnet 1	Subnet 2	Subnet 3	Subnet 4
IRI	> 2.5	> 3	> 4	> 4	> 5
Rut	> 6	> 6	> 9	> 9	> 15
LPV	>3	>4	>4	>5	>7

Sub-networks – Practical Implications

Different Treatment Reset values

Treatment	Parameter	Subnet				
Replace Surface (Relative Reset)		0	1	2	3	4
	RD	-2	-2	-2	-2	-2
	IRI	-0.5	-0.5	-0.5	-0.5	-0.5
	LPV3	-0.5	-0.5	-0.5	-0.5	-0.5
	CSC	0.6	0.6	0.6	0.6	0.6
Strengthen	RD	2	2	3	3	4
	IRI	1	1.4	2	2.2	2.2
	LPV3	0.8	0.8	1.2	1.2	1.2
	CSC	0.6	0.6	0.6	0.6	0.6
Overlay	RD	2	2	3	3	4
	IRI	1.2	1.7	2.2	2.5	2.5
	LPV3	0.8	0.8	1.2	1.2	1.2
	CSC	0.6	0.6	0.6	0.6	0.6
Reconstruct	RD	2	2	3	3	4
	IRI	1	1.4	2	2.2	2.2
	LPV3	0.8	0.8	1.2	1.2	1.2
	CSC	0.6	0.6	0.6	0.6	0.6

- Annual monitoring allows reset values to be adjusted to reflect what is achievable on the ground
- Overlay schemes where target resets are not being achieved on site can be identified quickly

Pavement Works Programme

- Subnetwork Definitions
- Subnetwork Thresholds
- Percentage above Threshold (PAT)
- Prioritisation based on PATs
- Rolling 3 year programme developed
- Rutting, Ride Quality, Short Wavelength
- Cracking, Ravelling will be added

Percentage Above Threshold (PAT)

- IRI, Rut Depth, LPV3 (short wavelength)

Example: Subnet 3, IRI poor threshold = 4 (250)

100m sample unit with IRI = 6,

PAT = 100*(6-4)/4 = 50%

Subnet 0, Rut Depth Poor threshold = 6 mm (0.25 inches)

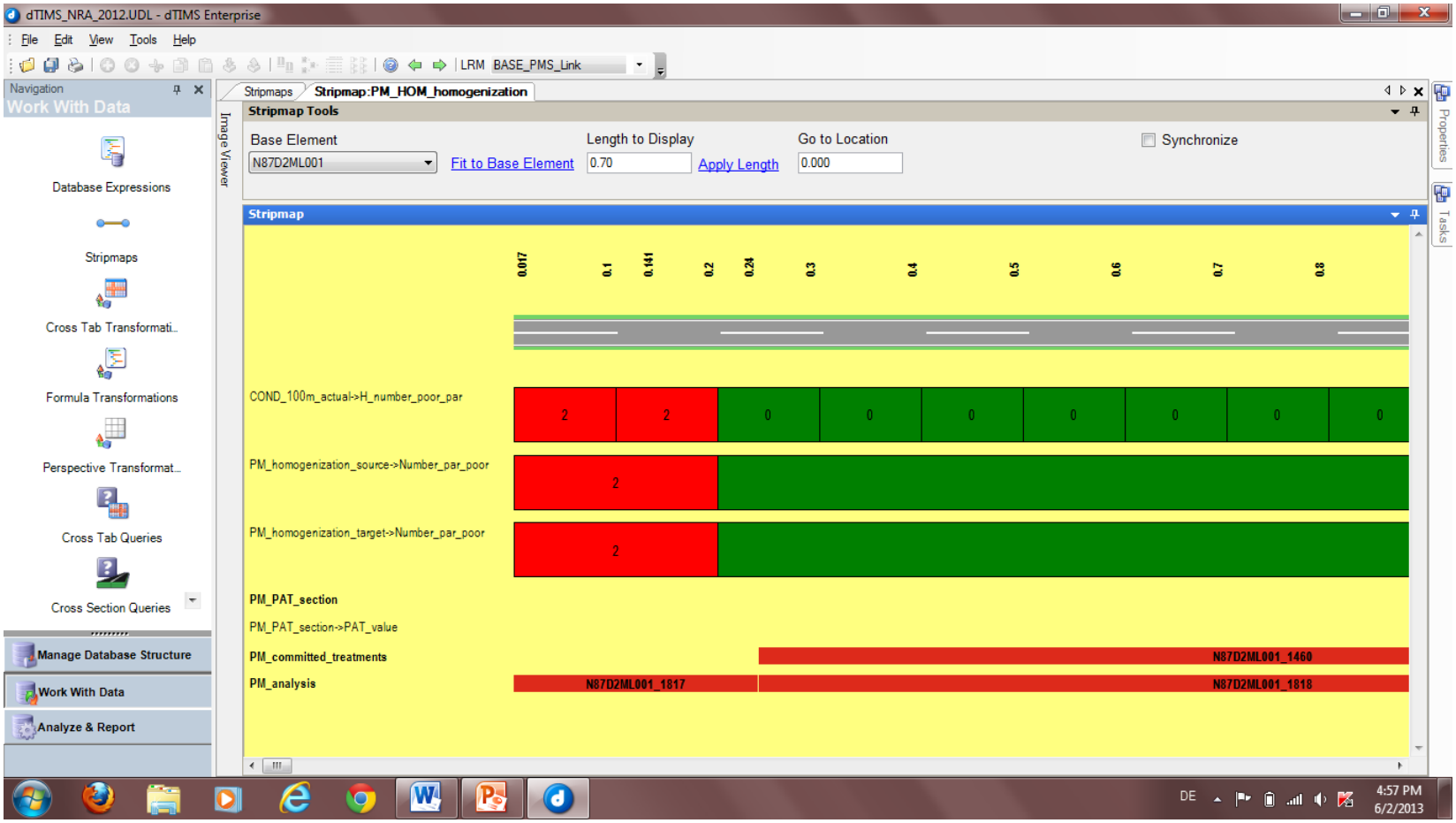
100m sample unit with Rut Depth = 12 mm,

PAT = 100*(12-6)/6 = 100%

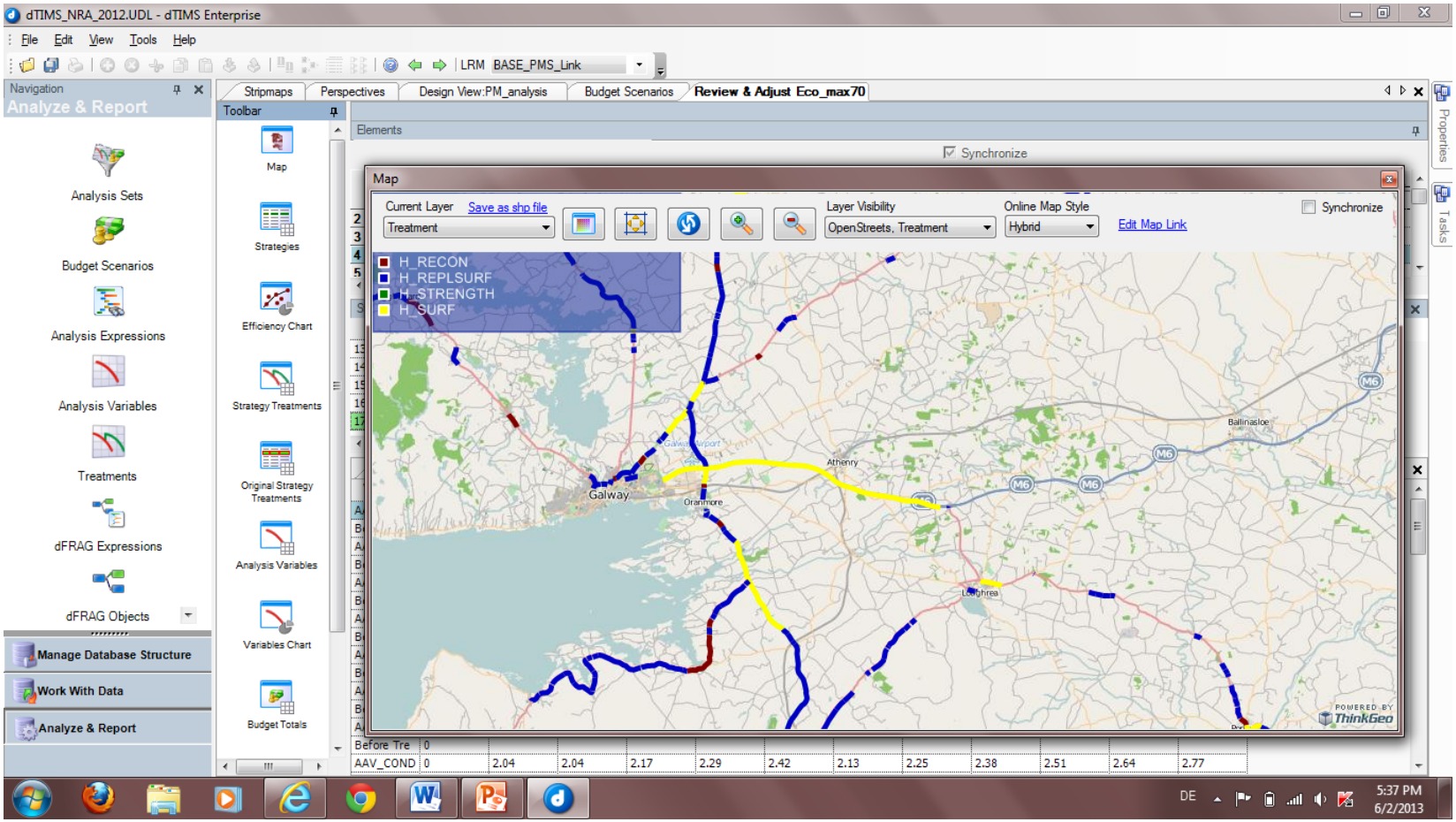
Prioritisation using PAT

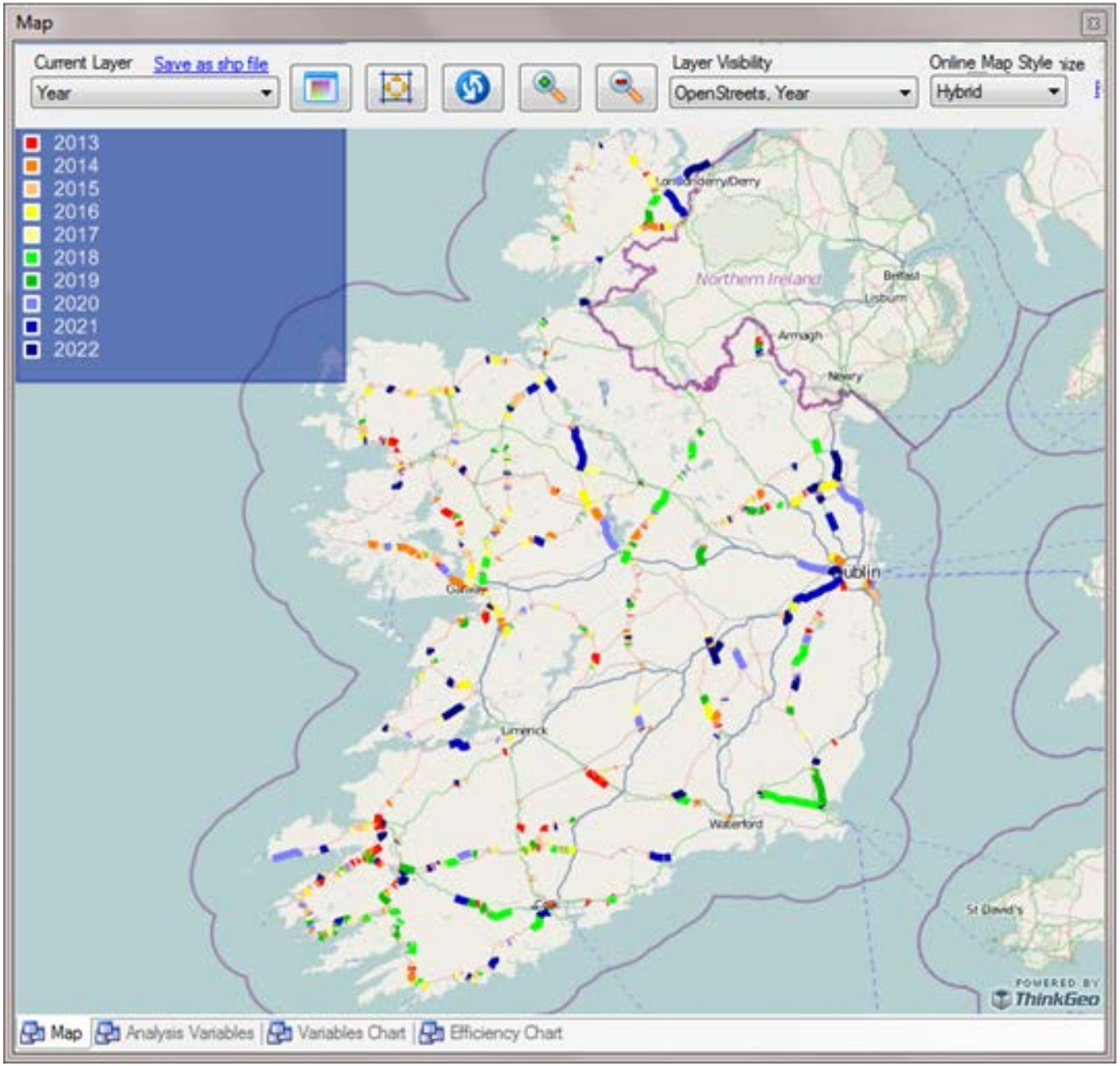
- 100m sample unit must have 2 parameters above threshold to be included
- PAT capped at 150% max for each parameter
- Sum of 2 highest PAT values is Representative PAT
- Much better correlation with “local expert” scheme selection when 2 PAT approach is used
- Combination of 100m PAT sample units into final schemes described in the paper
- Approach has been key to acceptance of PMS selected schemes over previous local “bid” system

Project Level Analysis and Prioritisation - dTIMS



Implementation in dTIMS




Map
Current Layer
Save as shp file
Year
Layer Visibility
OpenStreets, Year
Online Map Style
Hybrid
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Northern Ireland
Belfast
Lisburn
Armagh
Newry
Dublin
Galway
Limerick
Waterford
St David's
POWERED BY ThinkGeo
Map
Analysis Variables
Variables Chart
Efficiency Chart

Management of Skid Resistance

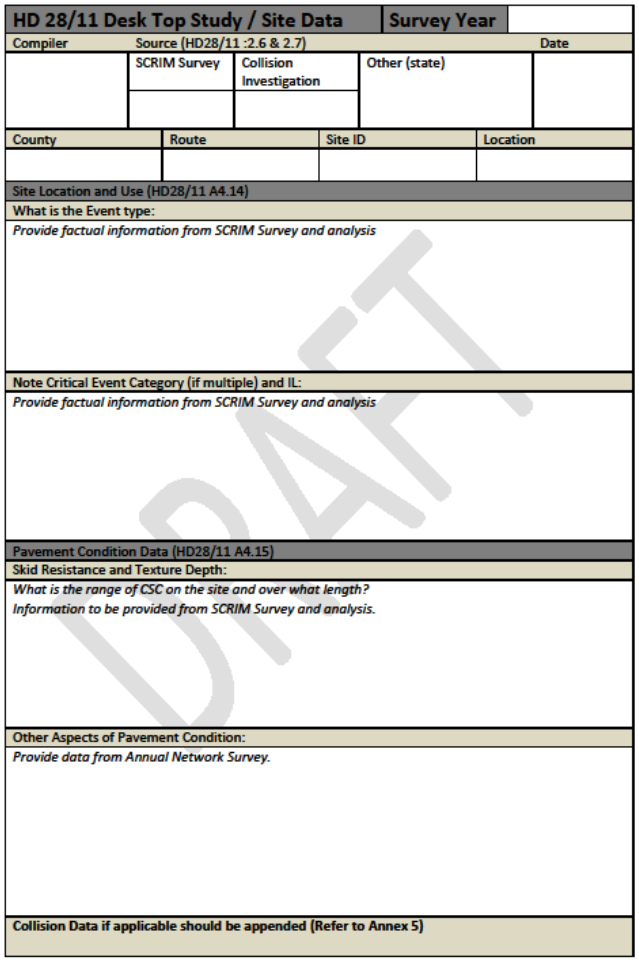
- Division of network into sections/site categories
- Risk Equalisation
- Motorway mainline versus 2 lane road with tight radius bend
- Prioritisation of Investigation based on points below Threshold
- SCRIM machine used for Data

Site Categories and IL – HD28/11

Site category and definition		Investigatory Level at 50km/h							
		0.30	**0.35**	**0.40**	**0.45**	**0.50**	**0.55**	**0.60**	**0.65**
A	Motorway								
B	Dual carriageway non-event								
C	Single carriageway non-event								
G1	Gradient 5-10% longer than 50m								
G2	Gradient >10% longer than 50m								
K	Approaches to traffic signals. pedestrian crossings								
Q	Approaches to and across major and minor junctions,								
R	Roundabout								
S1	Bend radius <250m – dual carriageway								
S2	Bend radius <250m – single carriageway								

Traffic > 250 commercial vehicles / lane/ per day
Traffic < 250 commercial vehicles/lane/ per day

Site Inspection



HD 28/11 Desk Top Study / Site Data			Survey Year	
Compiler	Source (HD28/11 :2.6 & 2.7)			Date
	SCRIM Survey	Collision Investigation	Other (state)	

County	Route	Site ID	Location

Site Location and Use (HD28/11 A4.14)

What is the Event type:

Provide factual information from SCRIM Survey and analysis

Note Critical Event Category (if multiple) and IL:

Provide factual information from SCRIM Survey and analysis

Pavement Condition Data (HD28/11 A4.15)

Skid Resistance and Texture Depth:

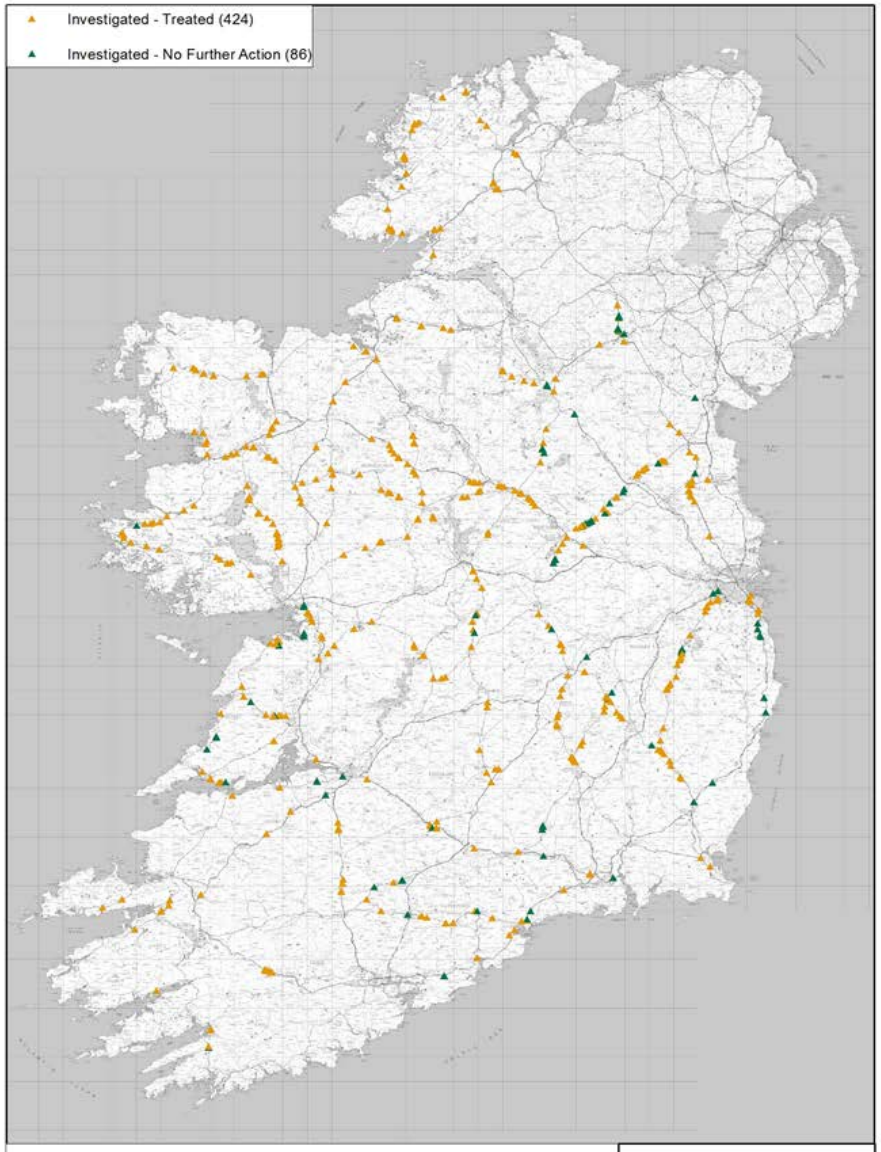
What is the range of CSC on the site and over what length?
Information to be provided from SCRIM Survey and analysis.

Other Aspects of Pavement Condition:

Provide data from Annual Network Survey.

Collision Data if applicable should be appended (Refer to Annex 5)

- Site Location and Use
- Pavement Condition Data
- Collision Data
- Video Data
- All downloaded to tablet app



HD28/11 Sites 2014

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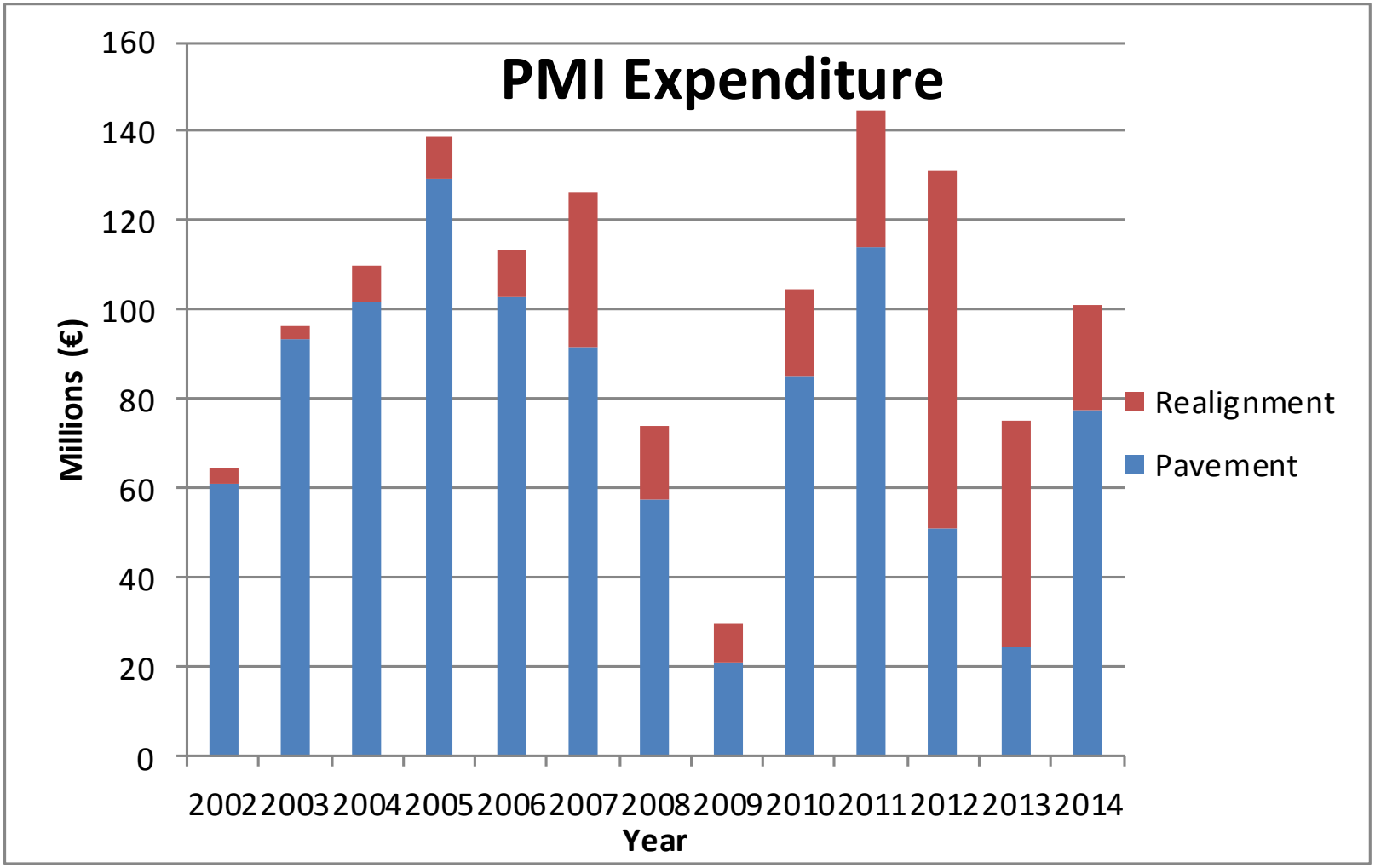
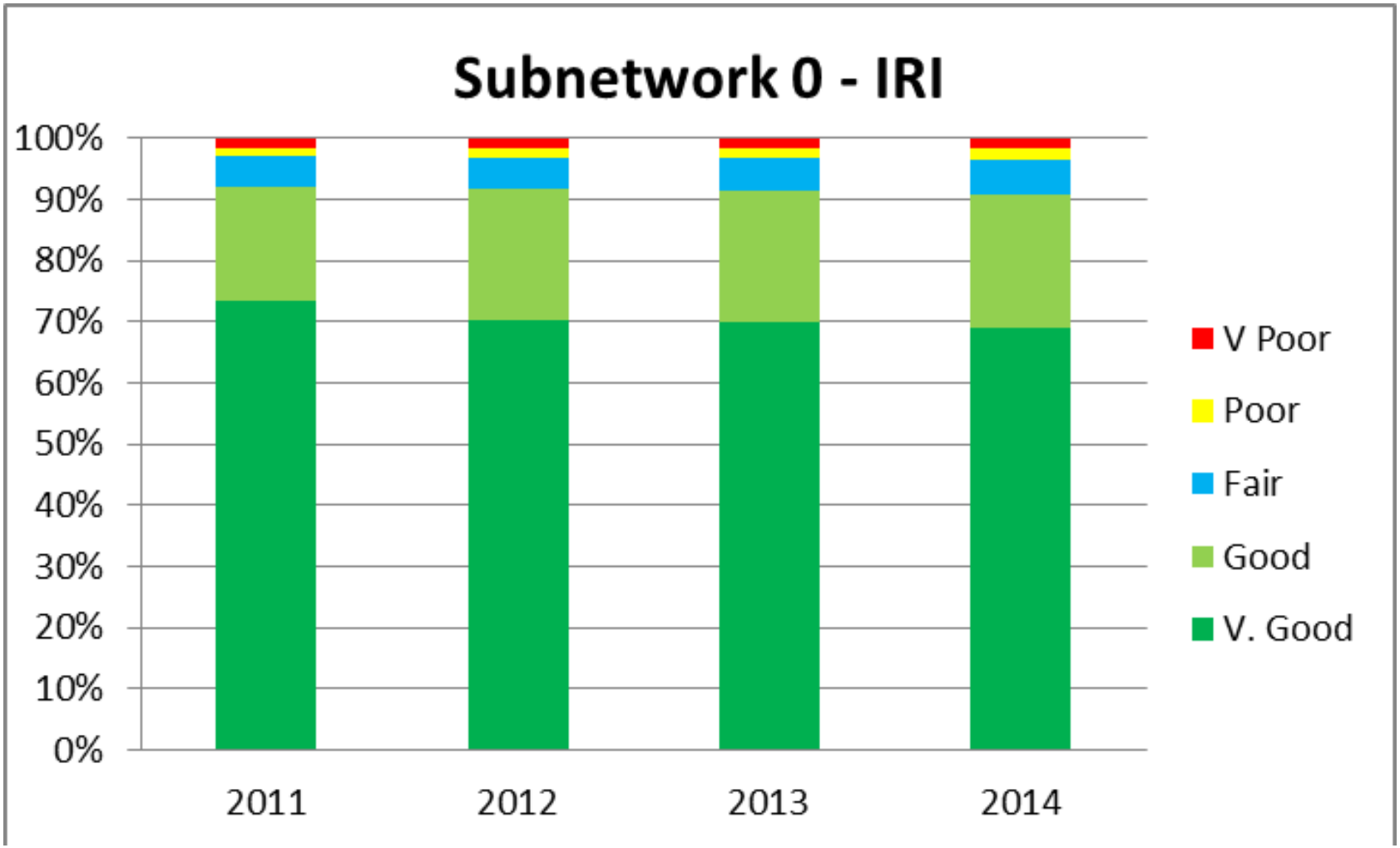
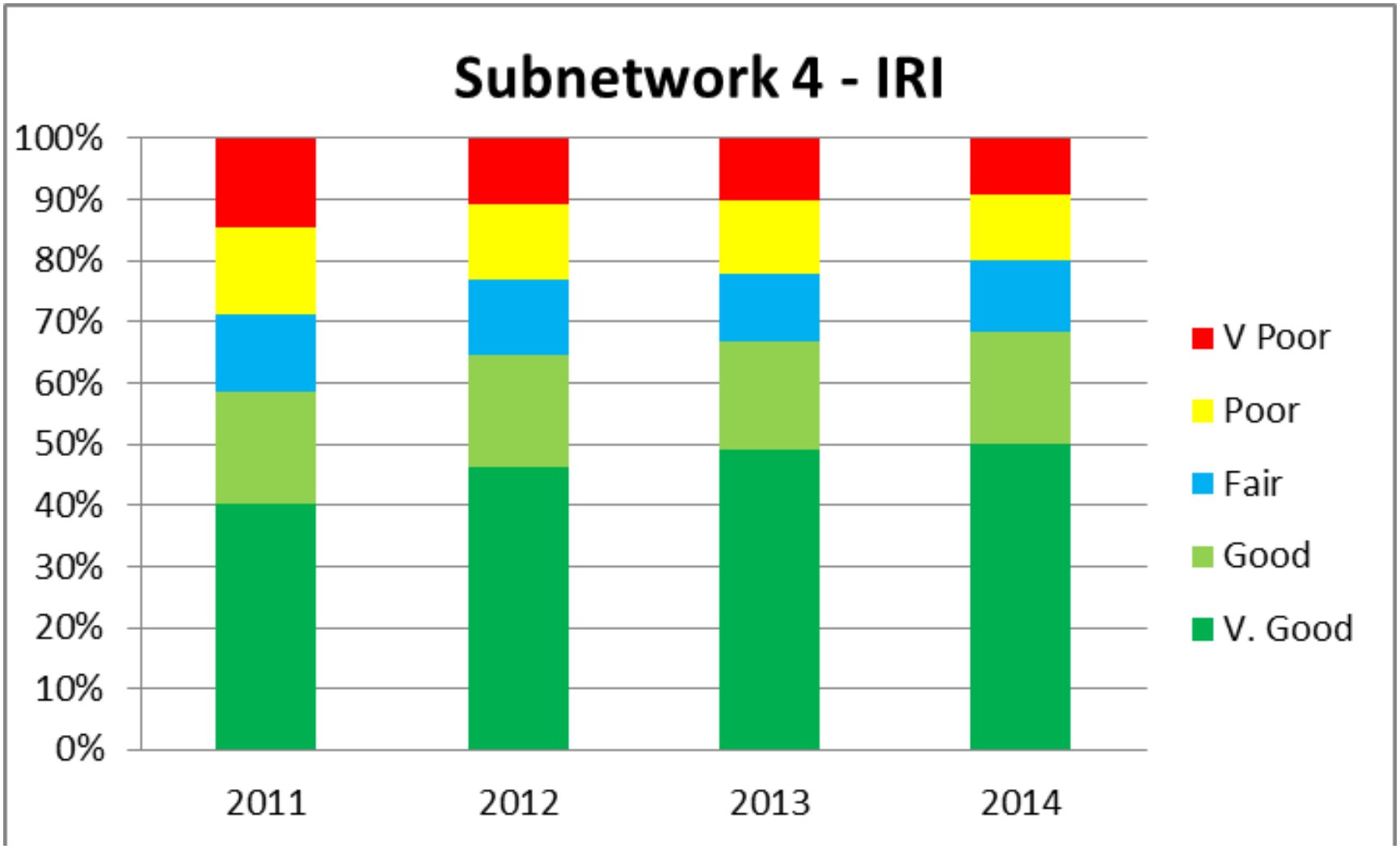
Summary

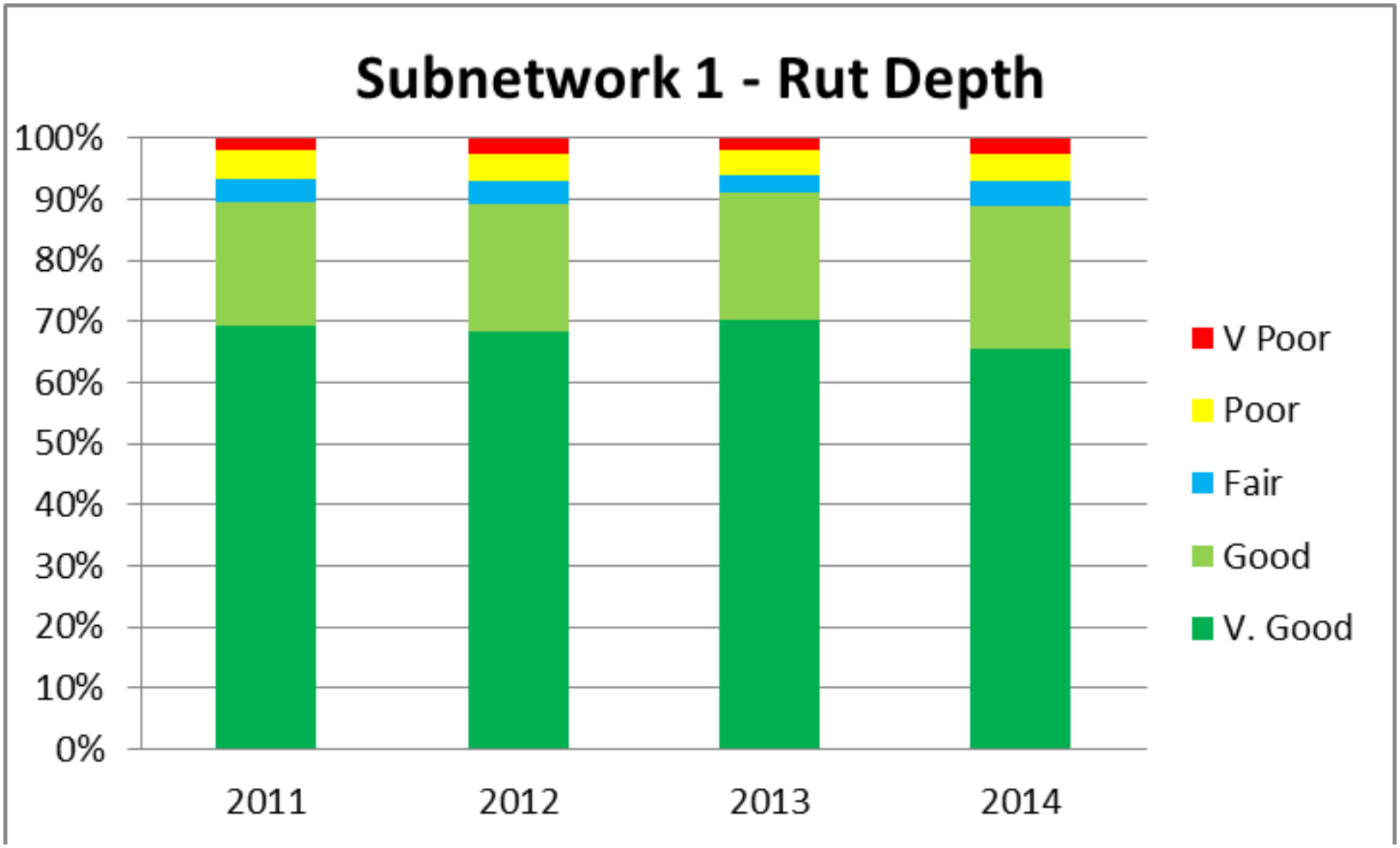
- Late Entrant – able to leverage off advances in technology
- Everything fully geo-referenced
- GIS at centre of all management systems including PMS
- Cloud-based image storage and access
- Subnetwork definition crucial for active management
- PAT approach led to acceptance of centralised scheme selection
- Active Skid Resistance Management

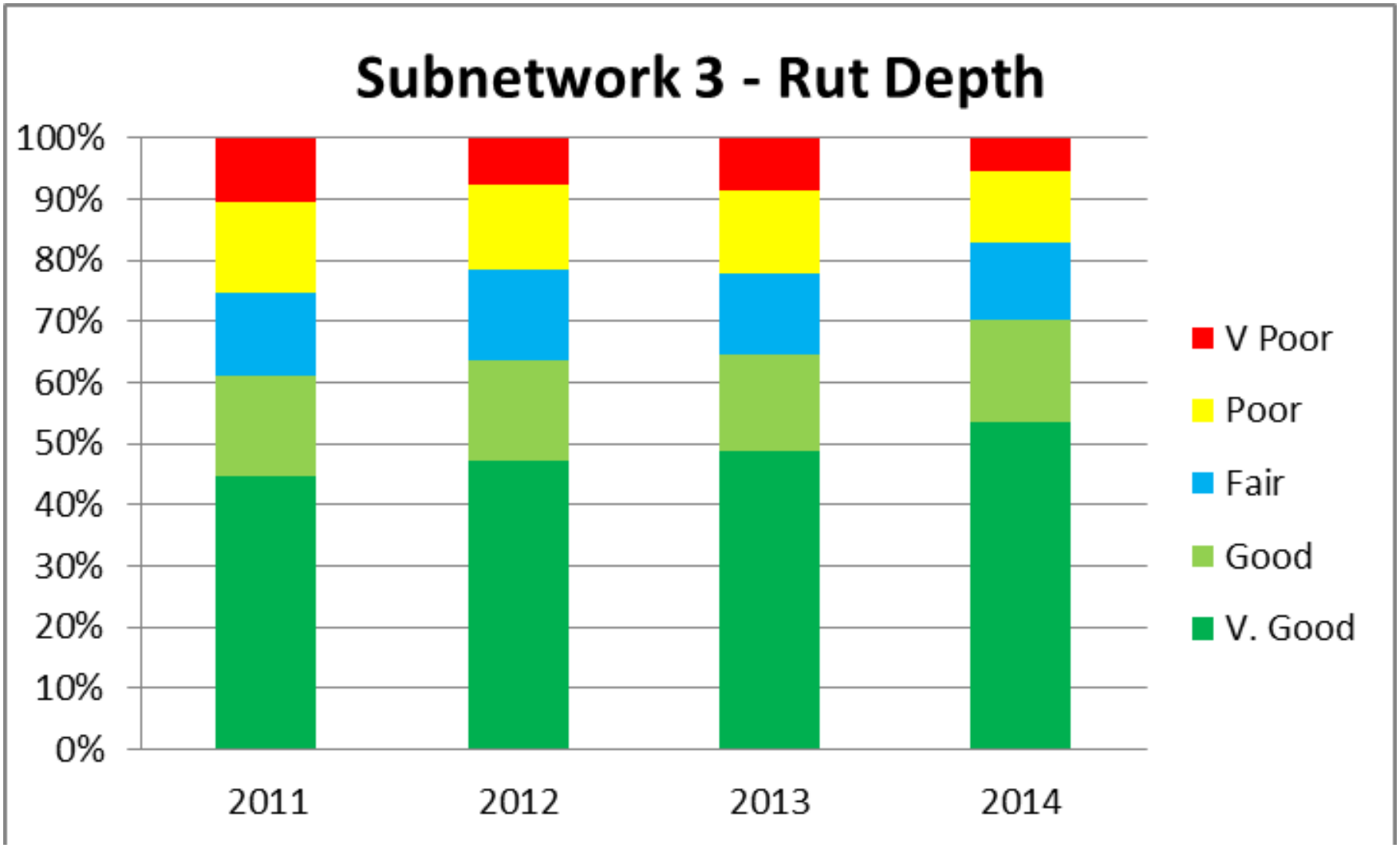
Is it working ?


PMI Expenditure
Millions (€)
160
140
120
100
80
60
40
20
0
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year
Realignment
Pavement


Subnetwork 0 - IRI
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2011
2012
2013
2014
V Poor
Poor
Fair
Good
V. Good


Subnetwork 4 - IRI
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2011
2012
2013
2014
V Poor
Poor
Fair
Good
V. Good


Subnetwork 1 - Rut Depth
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2011
2012
2013
2014
V Poor
Poor
Fair
Good
V. Good


Subnetwork 3 - Rut Depth
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2011
2012
2013
2014
V Poor
Poor
Fair
Good
V. Good