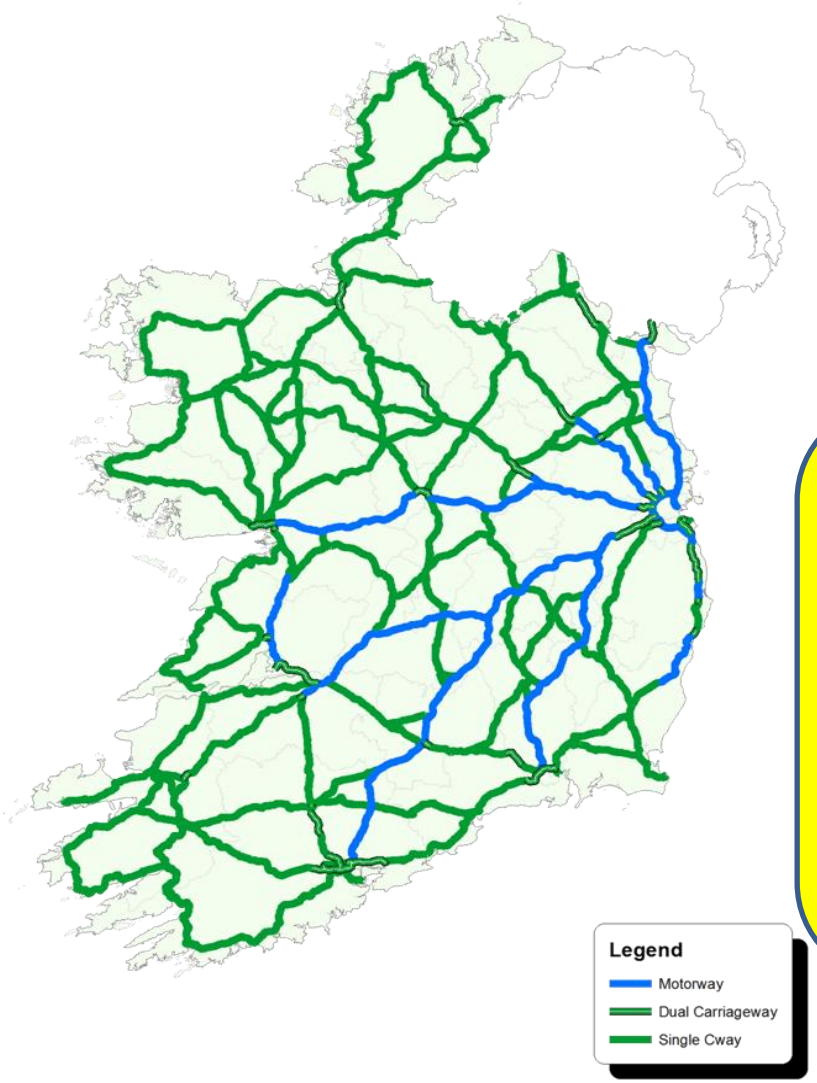
Application of dTims

for

Pavement Management of Irish Roads

National Road Network



- Total Network 5300km approx
- Motorway / Dual Carriageway 1200km approx
- Approx 50/50 NP/NS Split
- Up to end 2010 significant new build
- Post 2010 - Reduced funding & new build

Active Management required

- Get optimal use from asset
- Ensure asset is preserved
- Identify likely funding requirements to get a stated level of performance
- Make optimal use of the available funding

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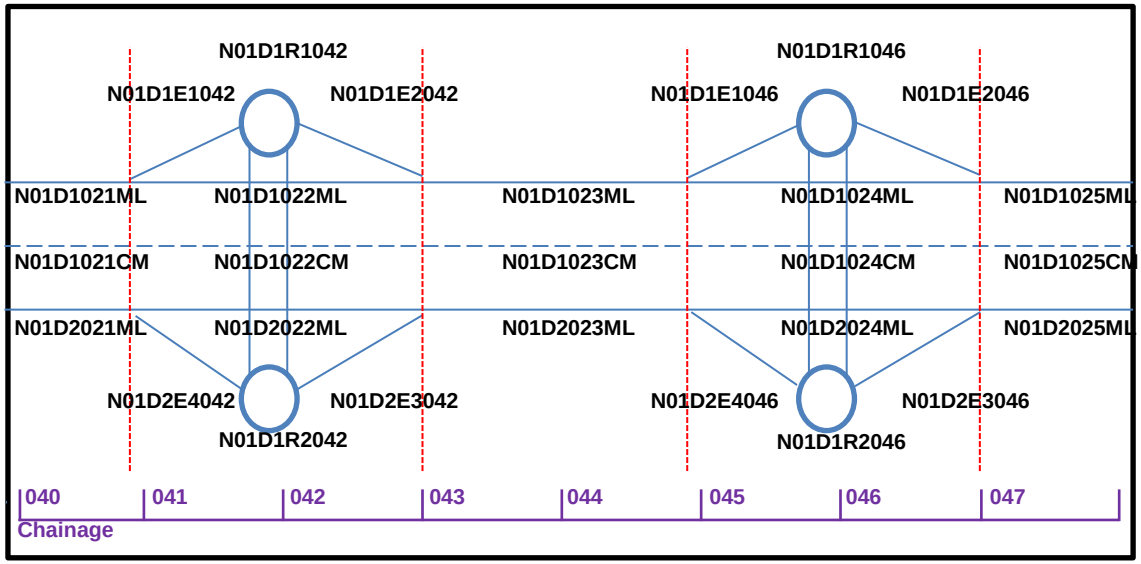
NRA Network Model

- Re-engineered Model developed
- All elements of network modelled
  - Mainline
  - Ramps
  - Roundabouts etc
- New Linear Referencing System
- Unique Identifier – needed to “hang” data on network



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Network Surveys

- Network Condition Survey (PMS Ltd, 6 yr Contract)
  - Annual
  - Full Network in 1 direction
  - Alternate Directions in subsequent years
    i.e. Year 1 - Northbound (D1)
    Year 2 – Southbound (D2)
- Condition Parameters
  - Skid Resistance (SC)
  - International Roughness Index (IRI)
  - 3 Metre Variance (LPV3)
  - Rut Depth
  - Macrotexture
  - Cracking (LCMS) – 2013 onwards
- Ground Penetrating Radar (One off survey in 2013)
- Route Geometrics – curves, gradients
- Video

← Used in dTims PMS

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Survey Data - SCRIM

HD 28 Management of Skid Resistance – Not managed within dTims

Survey Data - RSP

Road Surface Profilometer

- Rut Depth
- IRI
- LPV3
- Macrotexture

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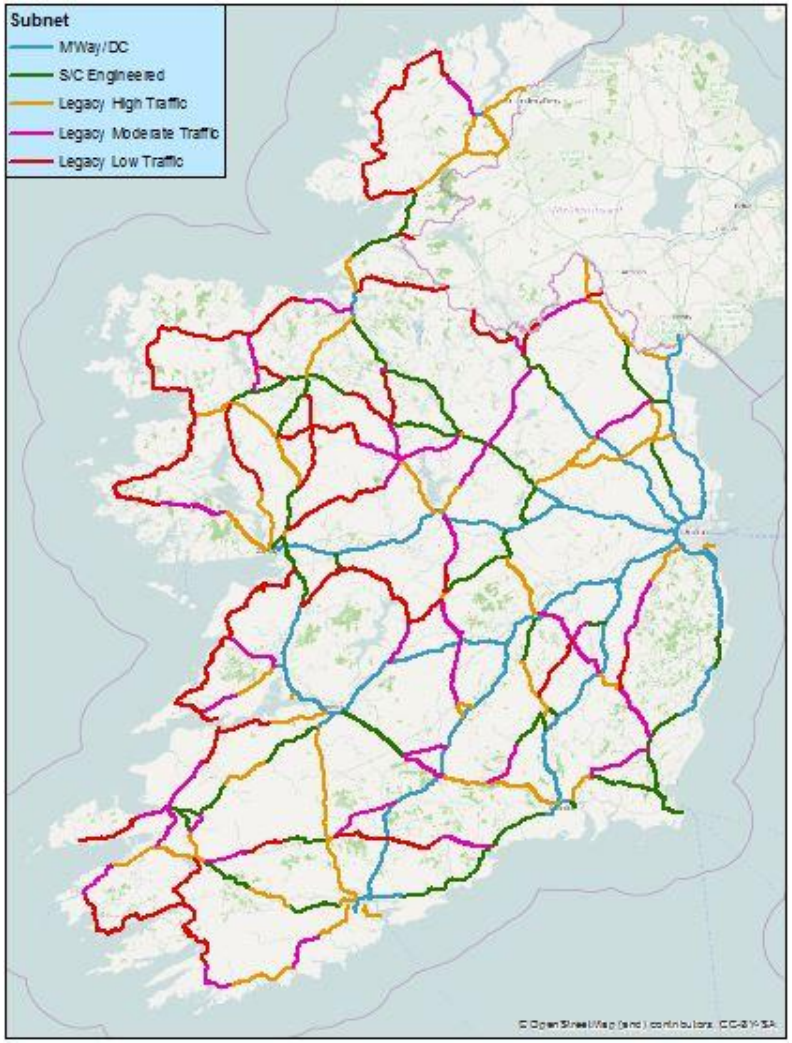
Sub Networks

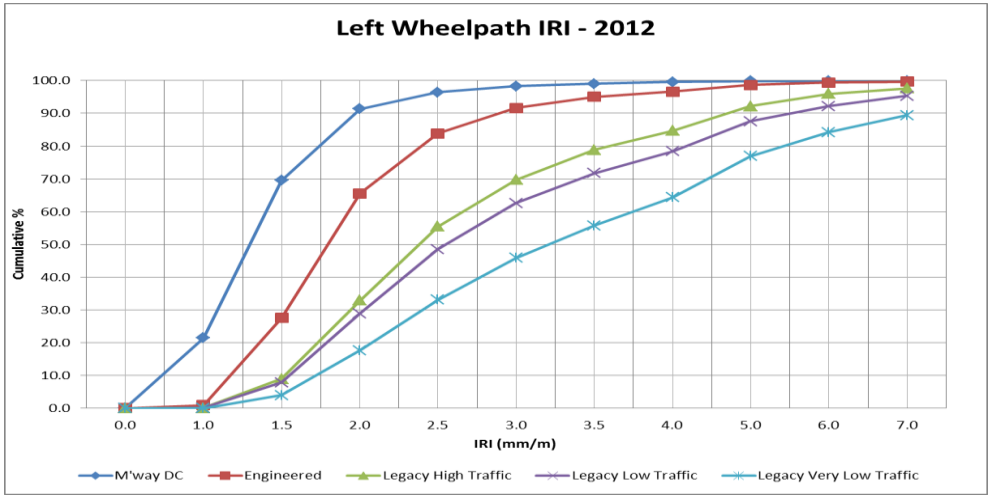
- National network is not homogenous.
  - Ranges from brand new fully engineered motorway to legacy pavements
  - Management of the network needs to recognise this variability in order to manage intelligently
  - Concept of Sub-networks introduced
- Classification Criteria
  - Network is either Engineered or Legacy (Non-Engineered)
  - Engineered Network
    - Motorway/Dual Carriageway or
    - Single Carriageway
  - Legacy Network
    - Single Carriageway
    - Traffic
      - High,
      - Moderate
      - Low

Sub Networks



Result is 5 sub-networks with measurably different condition distribution

- Subnet 0 – Motorway/Dual Carriageway
- Subnet 1 – SC Engineered
- Subnet 2 – Legacy HT
- Subnet 3 – Legacy MT
- Subnet 4 – Legacy LT



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Sub Networks – Performance Categories

- 5 Performance Categories
  Very Good – Very Poor
- Same Condition Parameters on all sub networks
  - IRI
  - Rut Depth
  - LPV3
- Different definitions of Very Good/Good/Fair etc for each sub network
- Reflects different performance requirements on different sub networks

e.g. **IRI = 3**

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
V. Good	< 1	< 1.5	< 2	< 2	< 2

Pavement Management – Live System

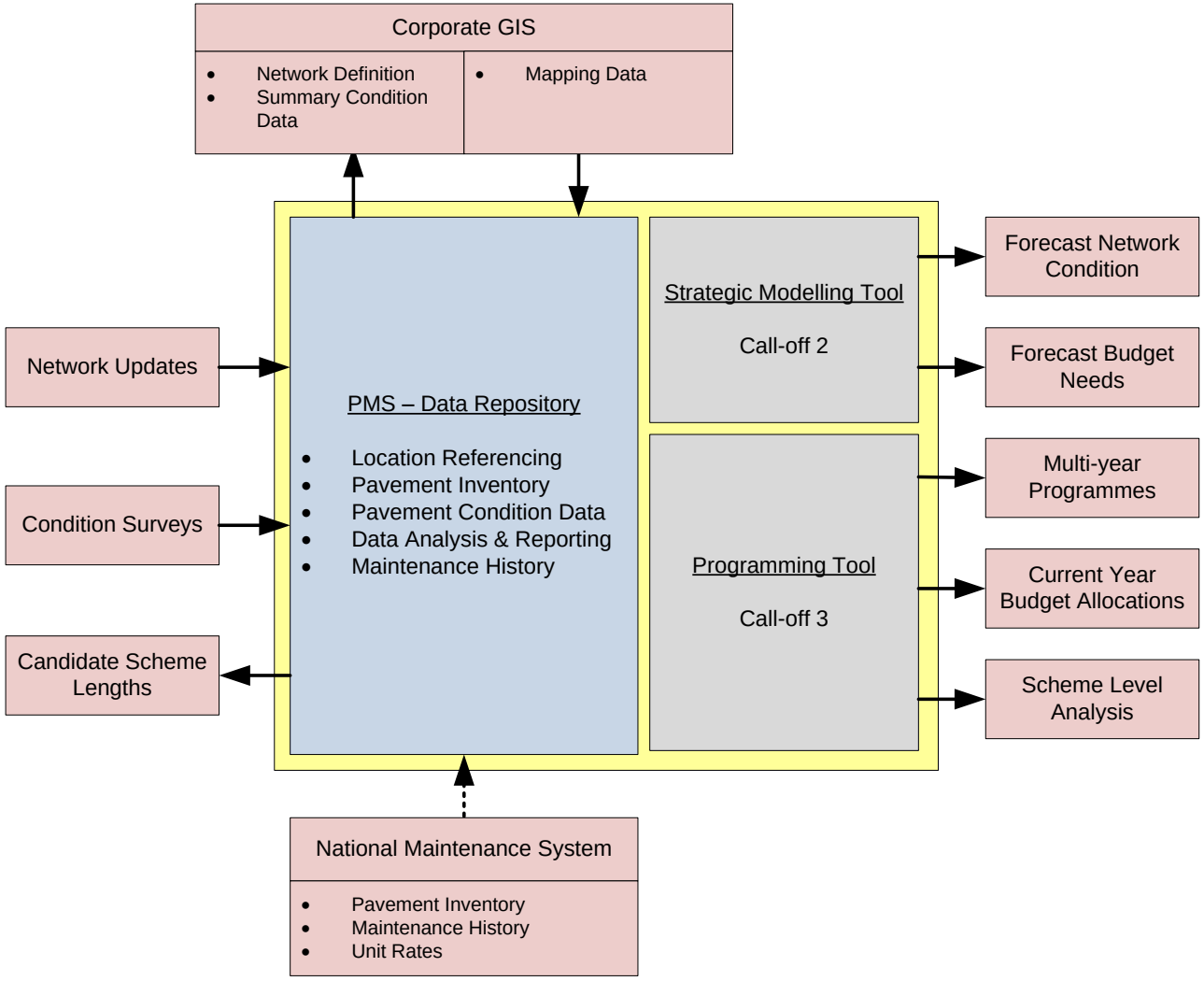
Live System – optimal solutions for defined performance target

- Targets – Overriding strategies that govern how pavements are managed
- Key Performance Indicators (KPI) – Used to measure performance in meeting defined target(s)
- Requires Knowledge & Data
- Analyses based on information within system
  - **Poor information → unreliable output**

Pavement Management – Live System

- Accurate Information
  - Survey data
    - Correct condition parameters
    - Quality Control
    - “Freshness” of the data
  - HD28 & Pavement schemes – as constructed
    - Start & End – to avoid Orphans & Duplicates
    - Depth – to predict Pavement life
    - Surface type – to schedule Surface Course renewal
    - Costs – to run Scenarios
  - Realignment & Safety Scheme
    - Most of the above
    - Network Model
      - Adjustment
      - Archive data
      - Pavement Condition Survey

dTims - Overview



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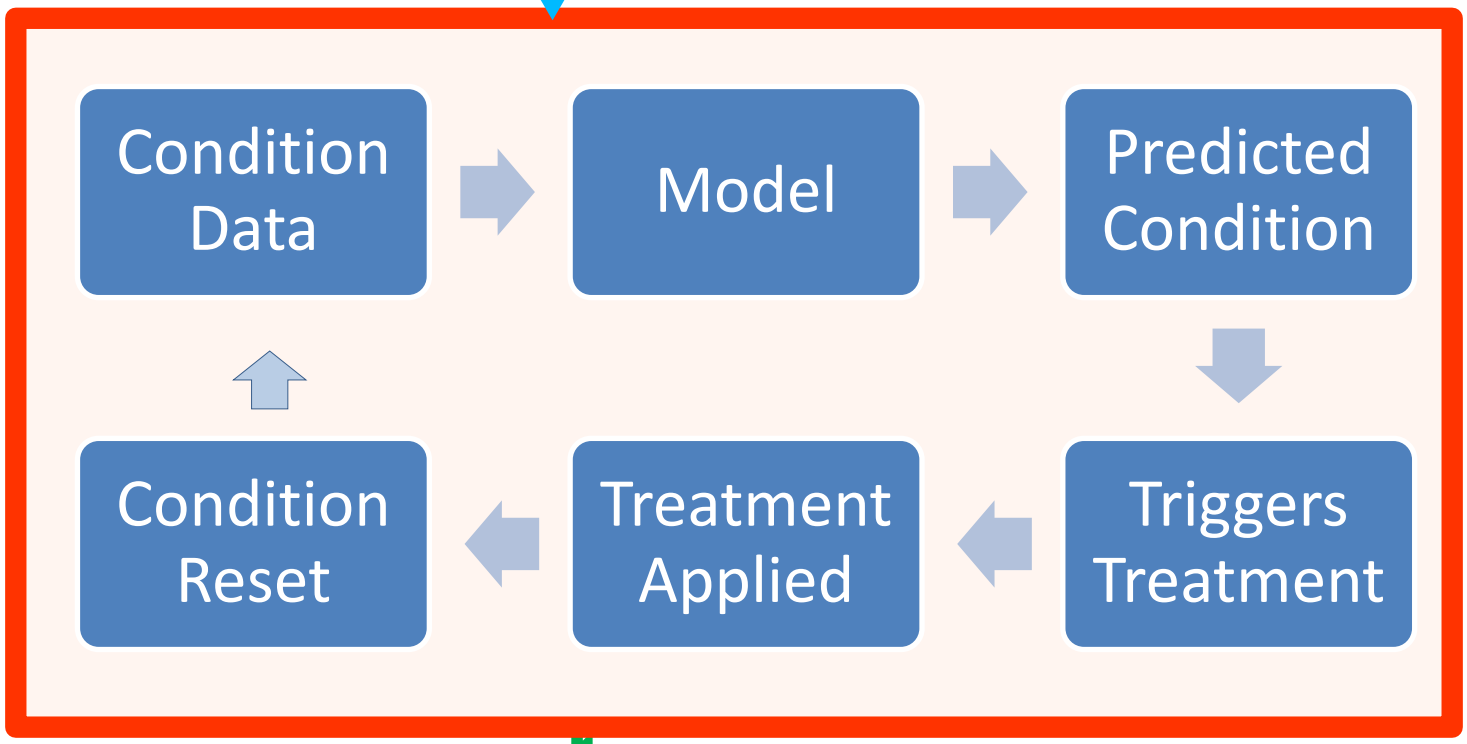
dTims

Strategy / Budget



Scenarios (Prioritised Treatments)

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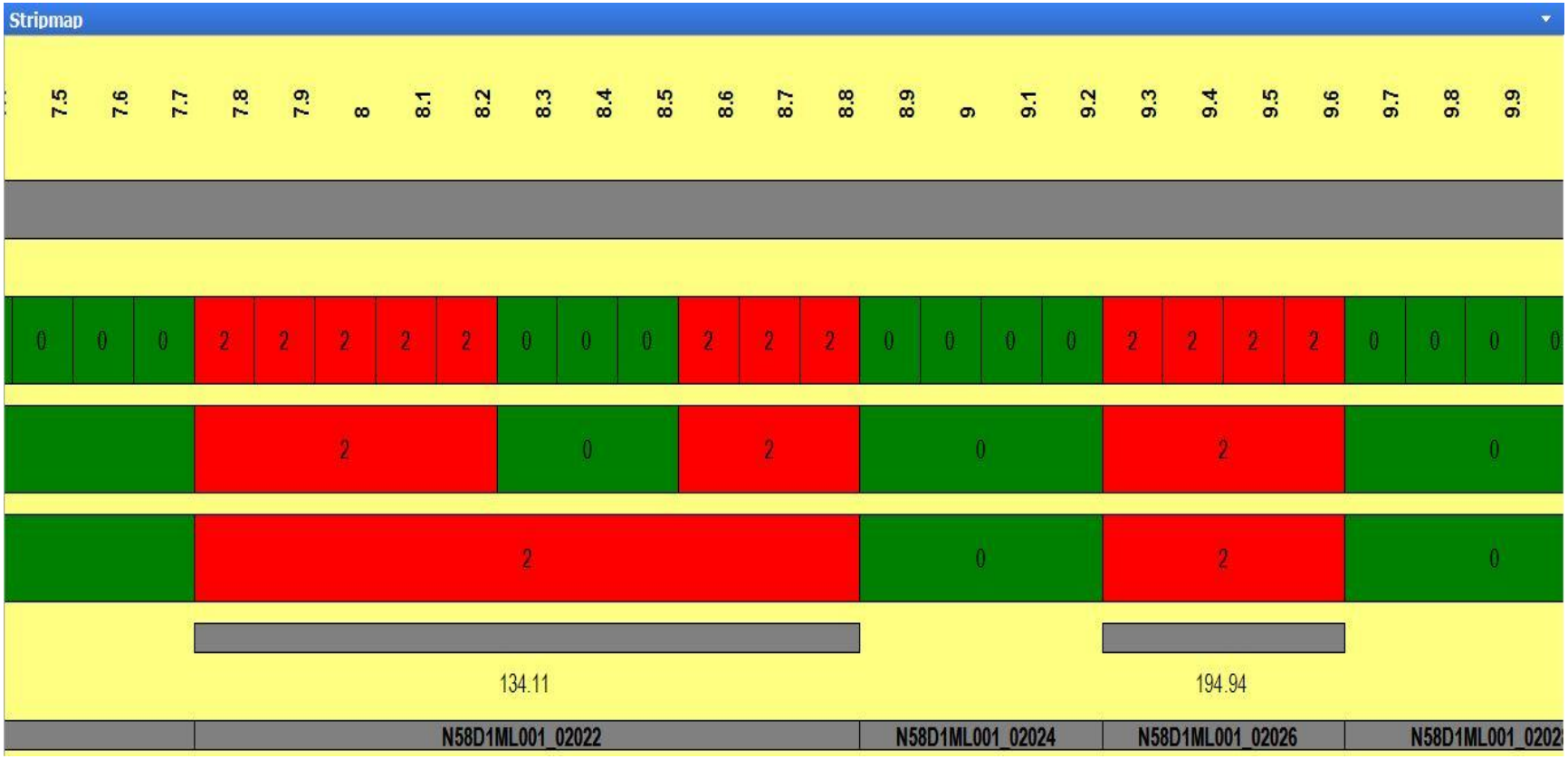
dTims - Homogenisation

Analysis Sections - prepared by the homogenisation of 100m condition data & other data e.g traffic, construction type



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dTims – Models & Sub networks

- 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

dTims – Treatment Trigger Matrix

		Ride Quality (IRI or LPV3)					
		Very Good	Good	Fair	Poor	Very Poor	
Rut	Very Good	N	N	N	O	O	T
	Good	N	N	N	O	O	T
	Fair	N	N	N	O	O	T
	Poor	O	O	O	O	O	T
	Very Poor	T	T	T	T	R	R

N = No Treatment/Age Based Treatment

O = Overlay

T = Strengthen

R = Reconstruction

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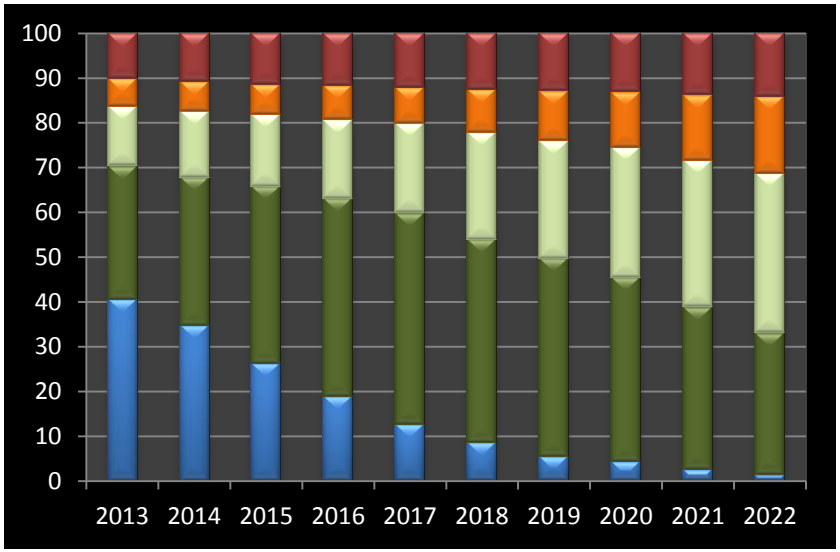
dTims – Treatments & Resets Matrix

Replace Surface Course (S)	Chip Seal, Micro-Surfacing, Thin Surface Overlay, Plane & Replace, Thin Surface (include pre-treatments)	Retard ageing, Restore Surface Characteristics Improve or restore functionality
Overlay (O)	Inlay 50-100mm, Overlay up to 100mm, Base / binder patching, (include pre-treatments)	Increase strength, retard ageing, improve or restore surface characteristics, improve or restore functionality
Strengthening (T)	Inlay 100-200mm, Overlay up to 200 mm	Increase strength, retard ageing, restore surface characteristics, improve or restore functionality
Reconstruction (R)	Full depth reconstruction (>200mm), Subbase reconstruct	Increase capacity, Increase Strength, Retard ageing

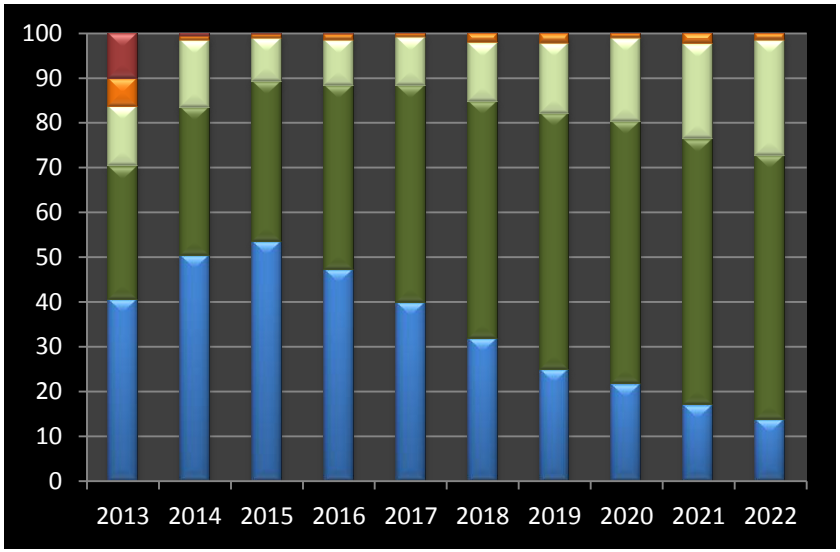
Treatments ←

Resets →

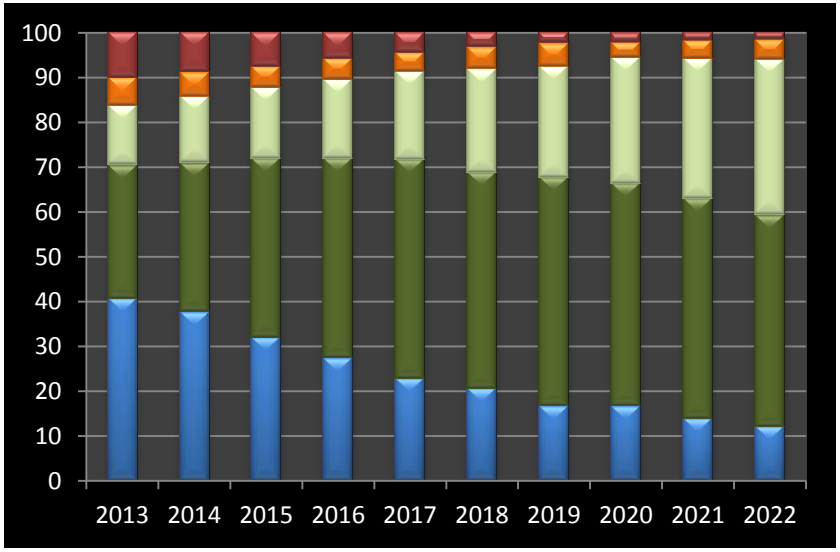
Treatment	Parameter	Subnet				
		0	1	2	3	4
Replace Surface (Relative Reset)	RD	-2	-2	-2	-2	-2
	IRI	-0.5	-0.5	-0.5	-0.5	-0.5
	LPV3	-0.5	-0.5	-0.5	-0.5	-0.5
Strengthen	RD	2	2	3	3	4
	IRI	1	1.4	2	2.2	2.2
	LPV3	0.8	0.8	1.2	1.2	1.2
Overlay	RD	2	2	3	3	4
	IRI	1.2	1.7	2.2	2.5	2.5
	LPV3	0.8	0.8	1.2	1.2	1.2
Reconstruct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



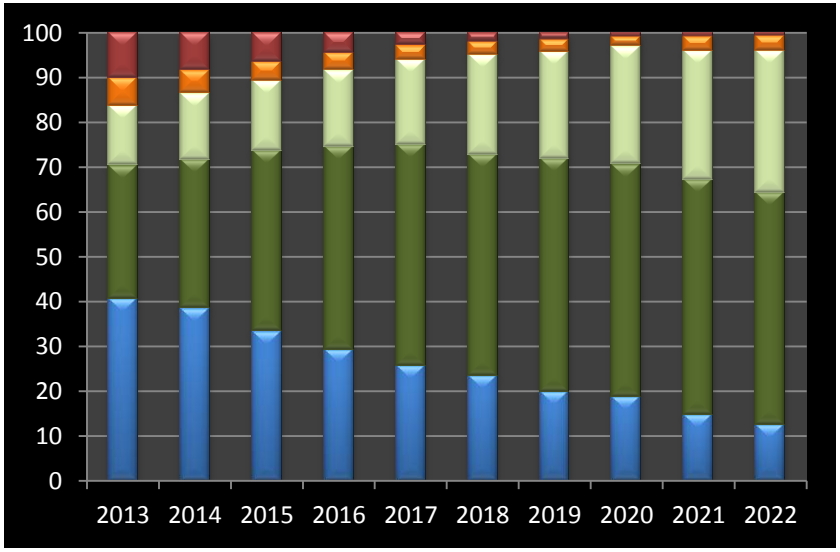
Do Nothing



Technical Optimum (Unlimited Budget)



€70M Budget per annum



No more than 5% Poor / Very Poor

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dTims - Sample Scenario Costs

Year	Do Nothing	Technical Optimum	€70 Million	Maintain under 5%
2013	0	€423,812,152	€69,994,008	€89,996,616
2014	0	€297,905,032	€69,996,752	€89,999,888
2015	0	€58,896,872	€69,997,096	€89,999,144
2016	0	€78,564,184	€69,995,240	€89,998,528
2017	0	€56,940,312	€69,998,984	€89,996,800
2018	0	€100,448,296	€69,999,480	€79,993,520
2019	0	€67,754,680	€69,989,216	€79,995,720
2020	0	€66,572,048	€69,999,560	€79,981,112
2021	0	€92,668,256	€69,998,520	€79,994,112
2022	0	€112,779,480	€69,991,976	€79,969,792
Total		**€1,356,341,312**	**€699,960,832**	**€849,925,232**

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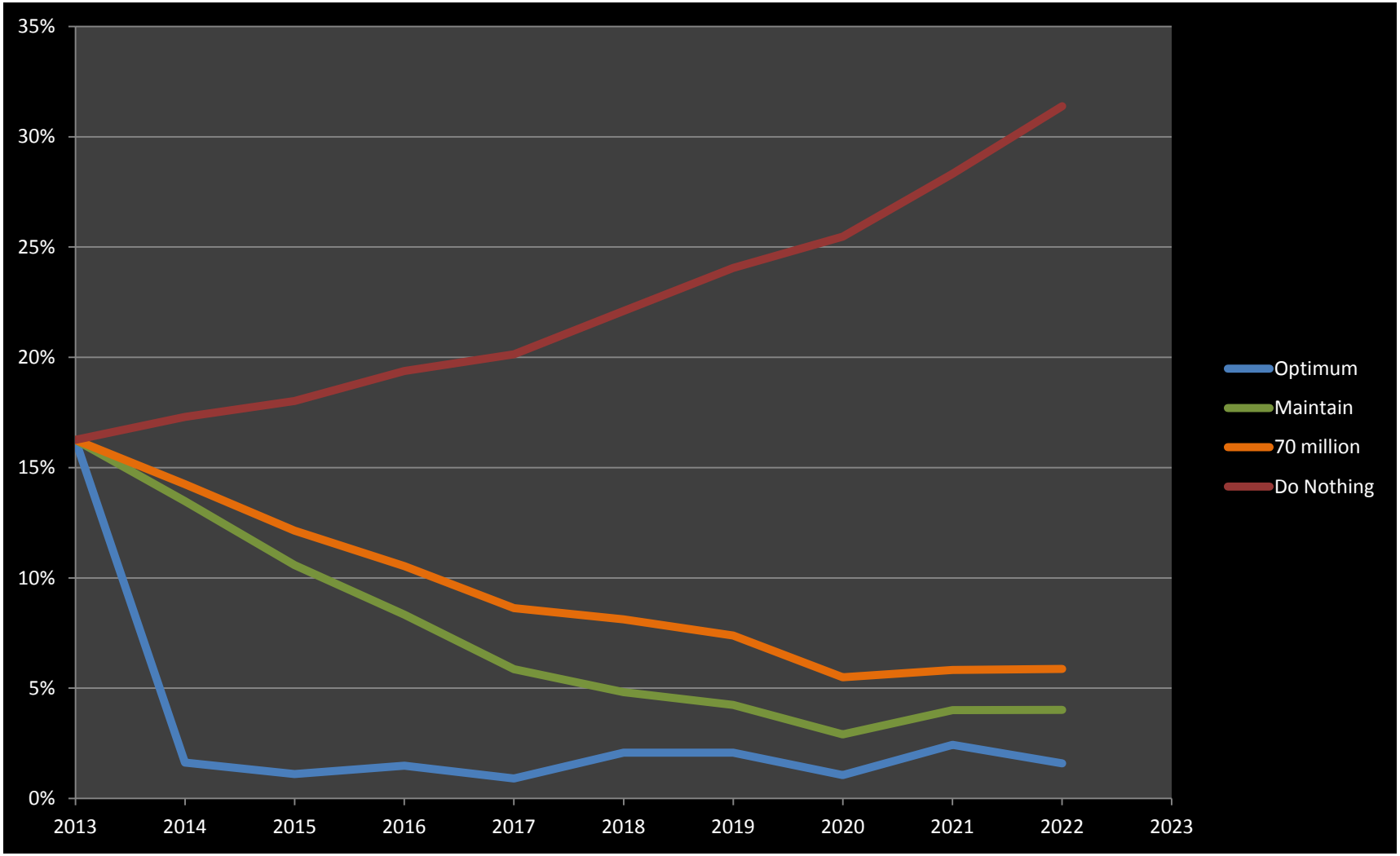
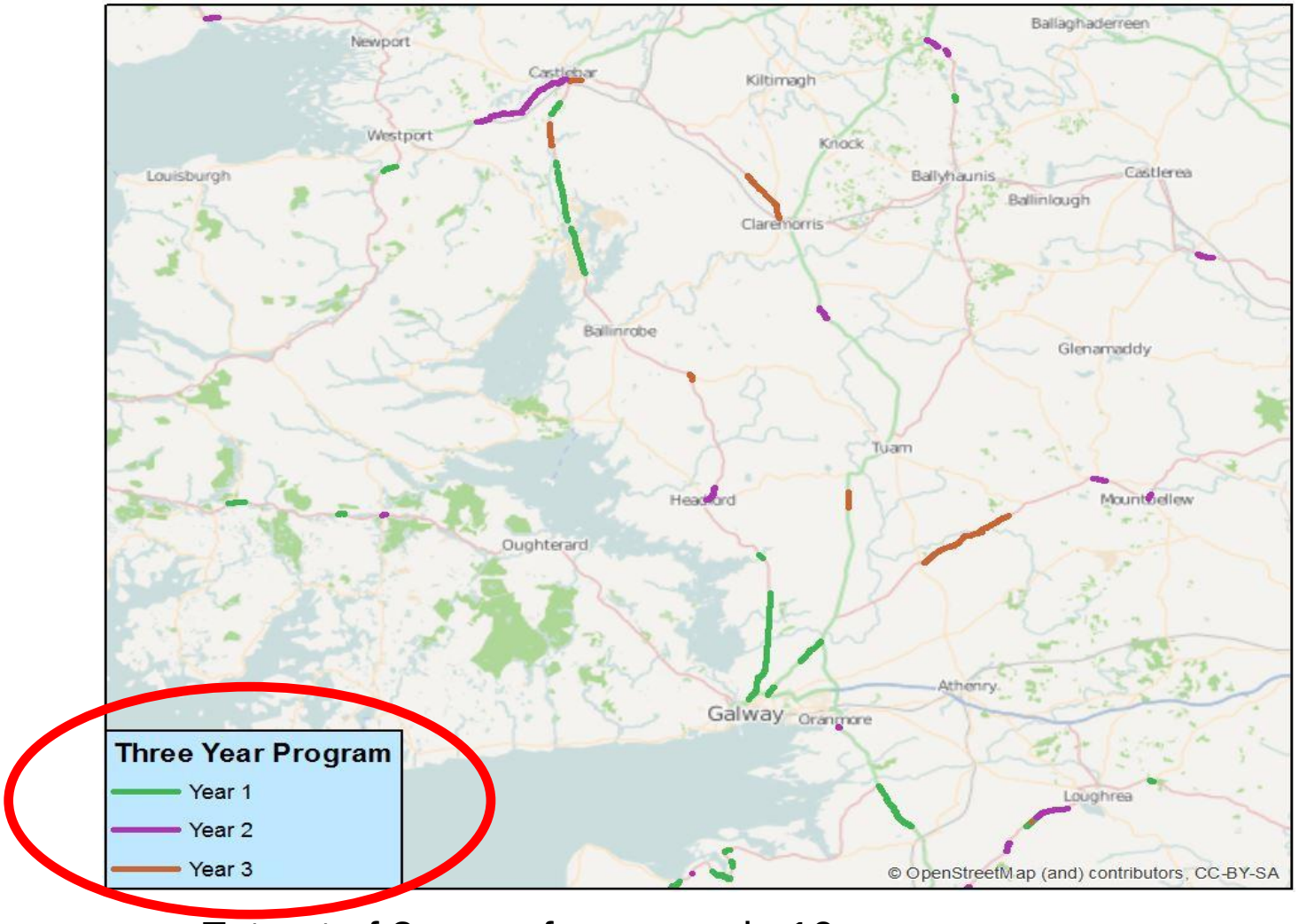
dTims - Works Programme Backlogs



% of Total Network in Poor or Very Poor Condition

dTims – Annualised Works Programme



Extract of 3 years from sample 10 year programme

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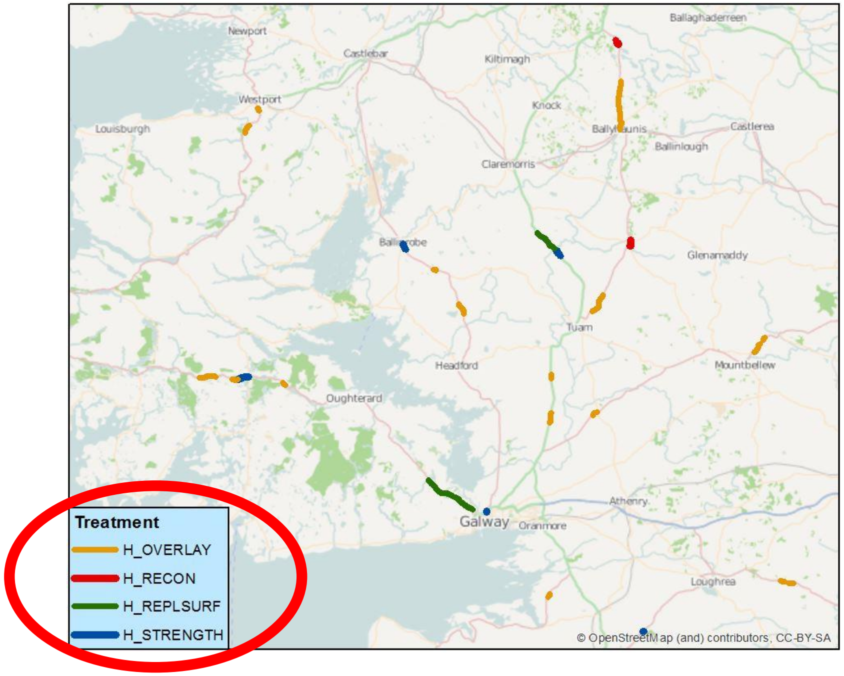
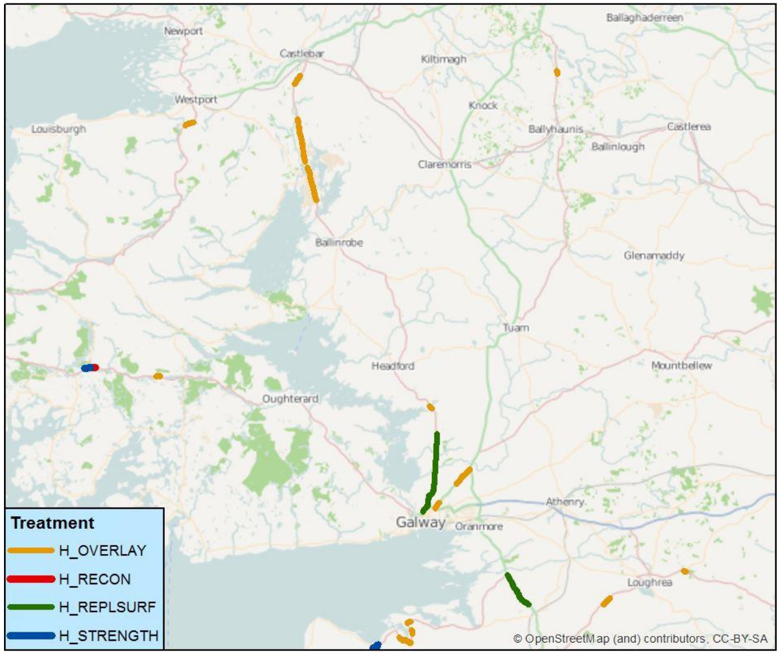
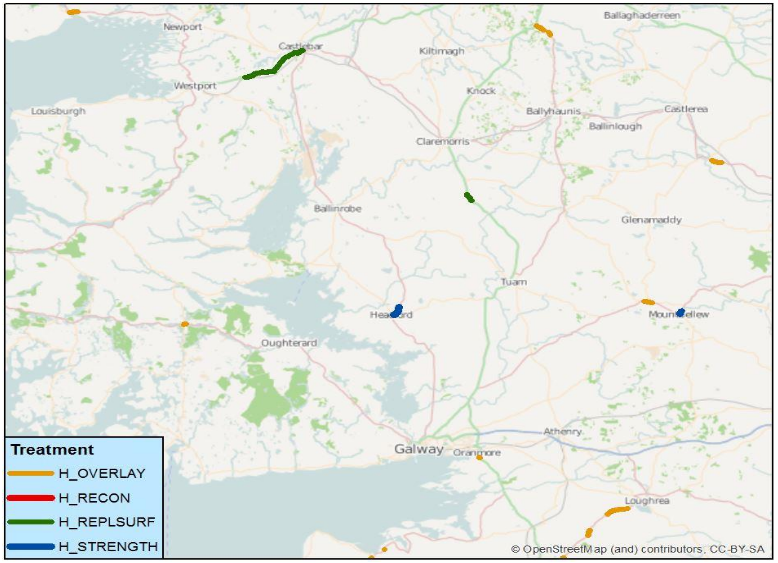
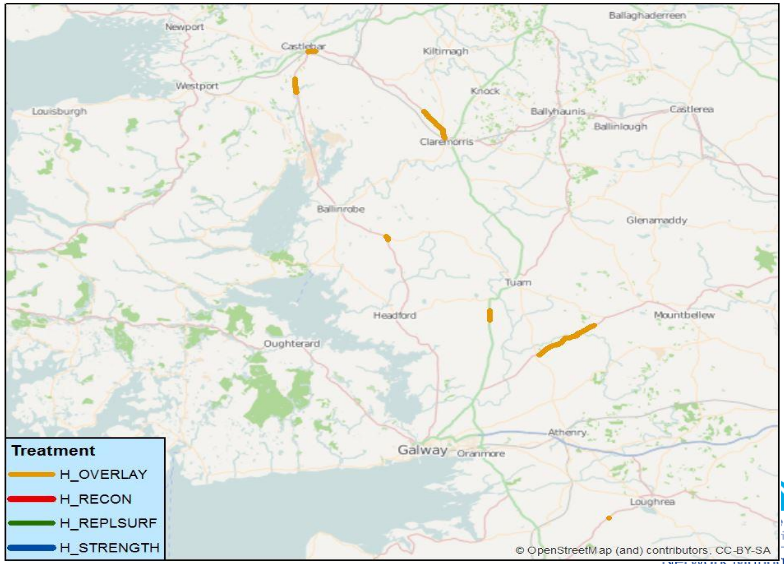
dTims – Treatment Types (in a year)



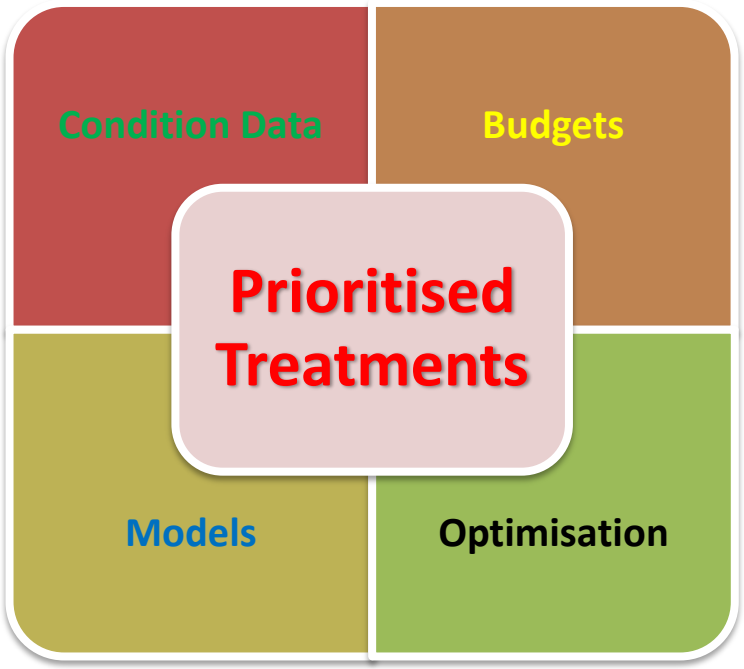






dTims - Pavement Management

"Grey Haired Man"



"Experienced Lady"

- Interrogate results
  - Are they reasonable
  - Do they meet requirements
- Optimise Procurement
  - Bring forward / Push back schemes
  - Co-ordinate with other programmes of work
- Consider other issues / inputs as they arise
- Develop intimate understanding of the system!

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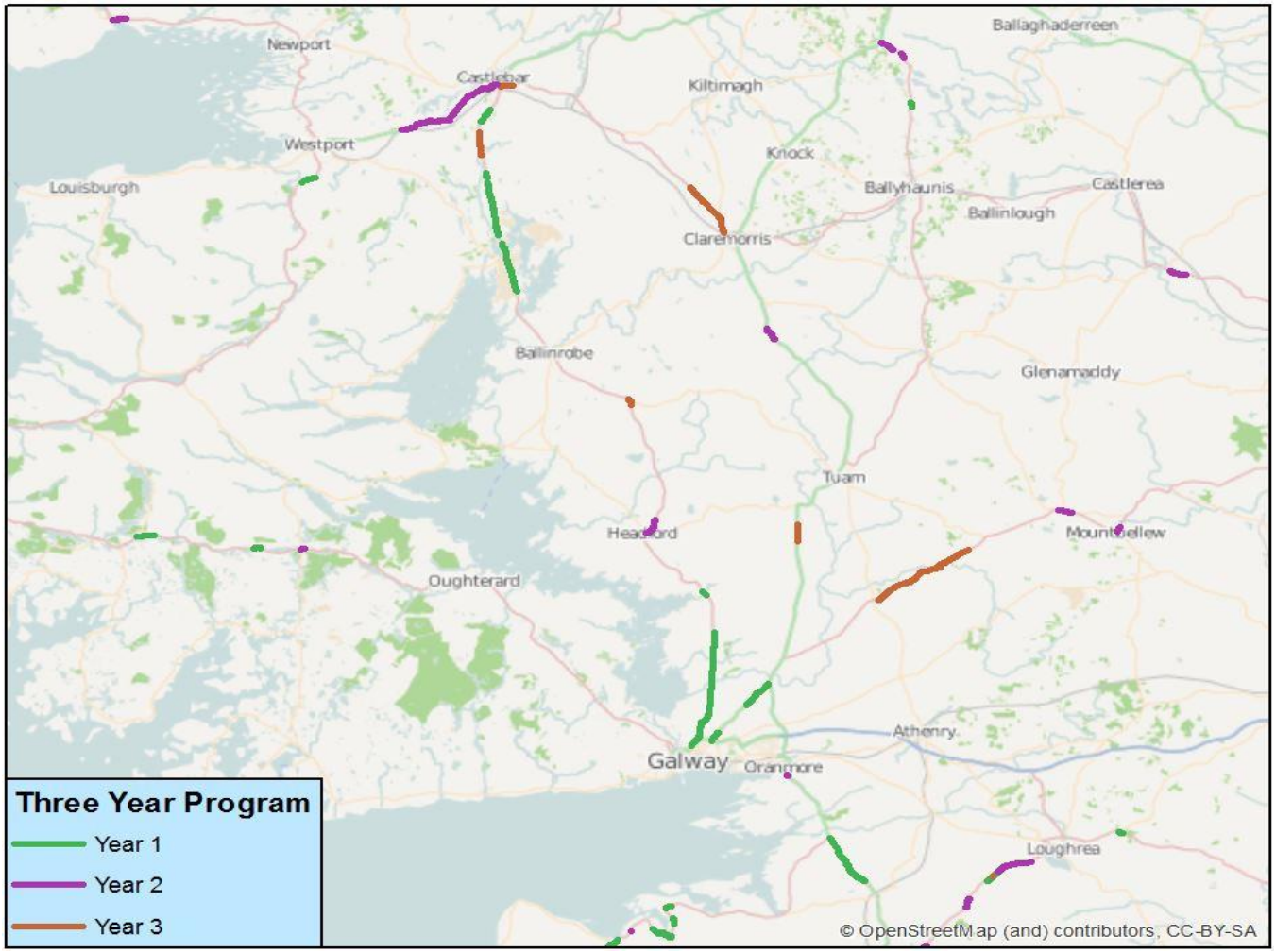
dTims – Annualised Works Programme



Extract of 3 years from sample 10 year programme

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Pavement Management – Constraints / Overriding Factors

- Output for a defined Performance Target

  Change of Target → Different Output

- Condition Data
  - Weather Events – Winter 2010, Flooding
  - Sudden significant change in traffic pattern

1. Change Inputs

   For example

   – Budget Profile (Performance Target)

   – Condition Data (Weather)

2. Rerun models
3. Re-optimise for Budget

Pavement Management – Constraints / Overriding Factors

- Local Works
  - Water main installation – LA vs. Irish Water
  - Communications – LA or NRA
- Realignments
  - Likely or wish list
  - Short, Medium or Long timescale
- Political Influence

Flag within dTims &
when identified for treatment
Adjust Treatment year

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Pavement Management – Constraints / Overriding Factors

Other Factors to be Considered

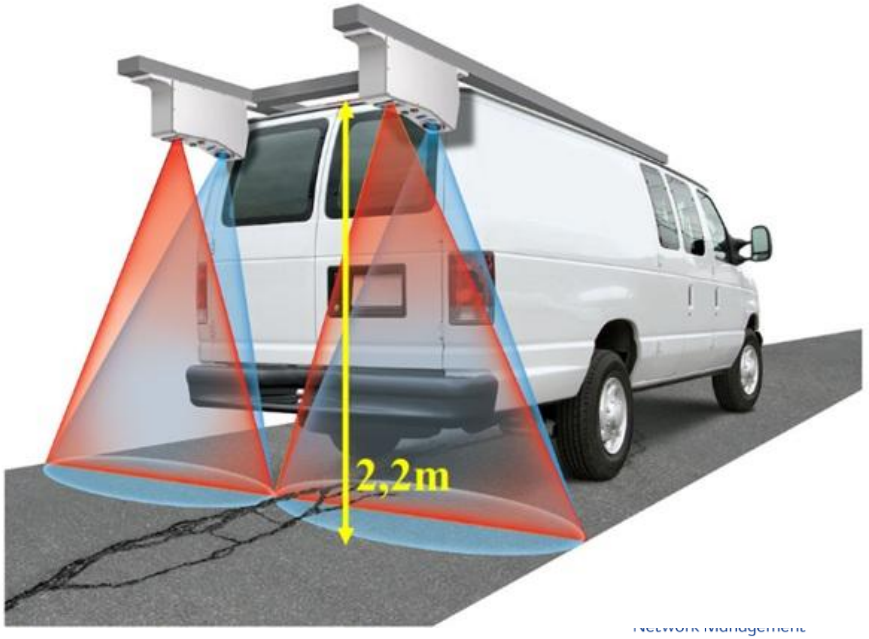
- Quarries –Lorries laden outbound, empty on return
  - Direction of survey may not pick up deterioration
- Bog Ramparts – perform differently and may not suit dTims models

"Grey Haired Man's" experience is required

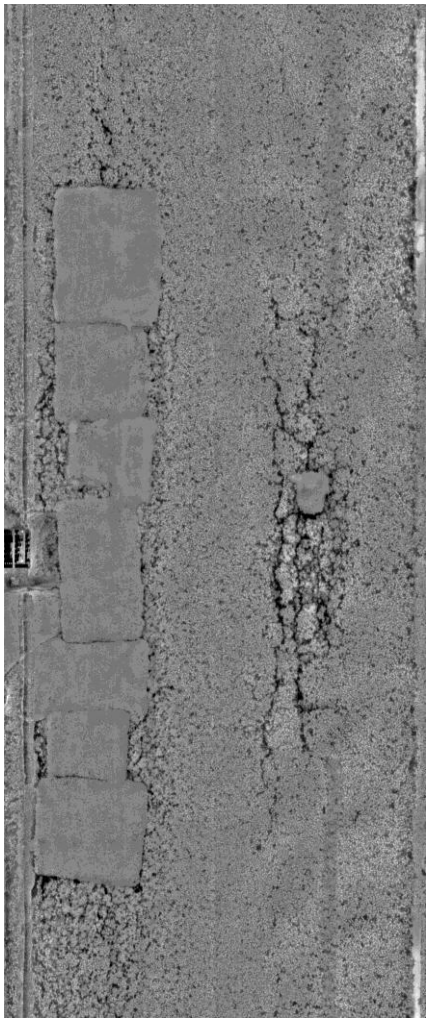
Future Progression – New Survey Data

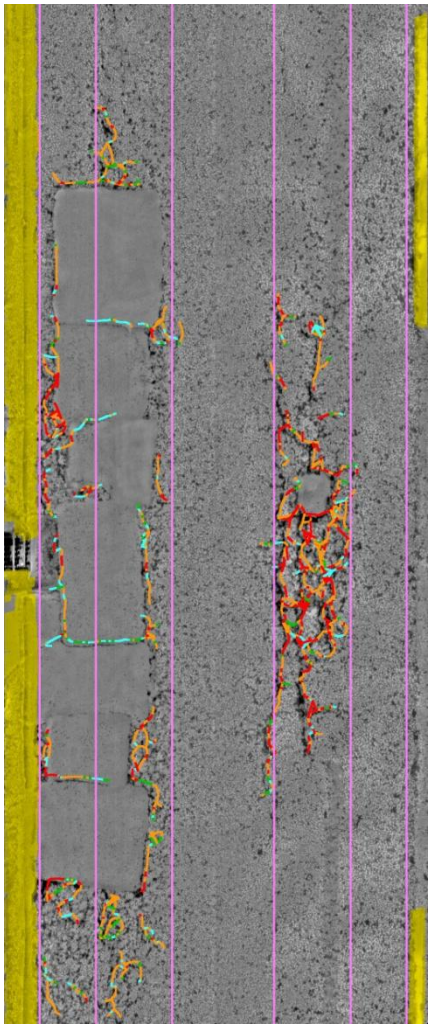
Cracking Measurement (LCMS)

- Laser
- Crack
- Measurement
- System



Future Progression – New Survey Data





- Type
  - How to quantify it
- Severity
  - How to rate it
- Modelling
  - How to use it
  - How to predict it

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Future Progression

- Deterioration Models – Refinement
  - Deterministic or Probabilistic
  - Reset Values
    - Annual monitoring allows adjustment to reflect what is achievable on the ground
  - New Condition Parameters (or make redundant)
- Costs – influence on quantum of works
- Sub network Condition Bands

  Periodic Review & Revision
- Sub network Definition

  Instead of / In addition to current definition
  - Socio Economic
  - Route to Hospitals
  - Critical Links (no alternative route)
  - Route to transport hubs / ports / motorway junctions etc

Thank You

Ray McGowan, PMS Ltd
Brendan Kennedy, GIS Manager, NRA
Andrew O'Sullivan, Engineering Inspector, NRA

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