



WP4 Alert management

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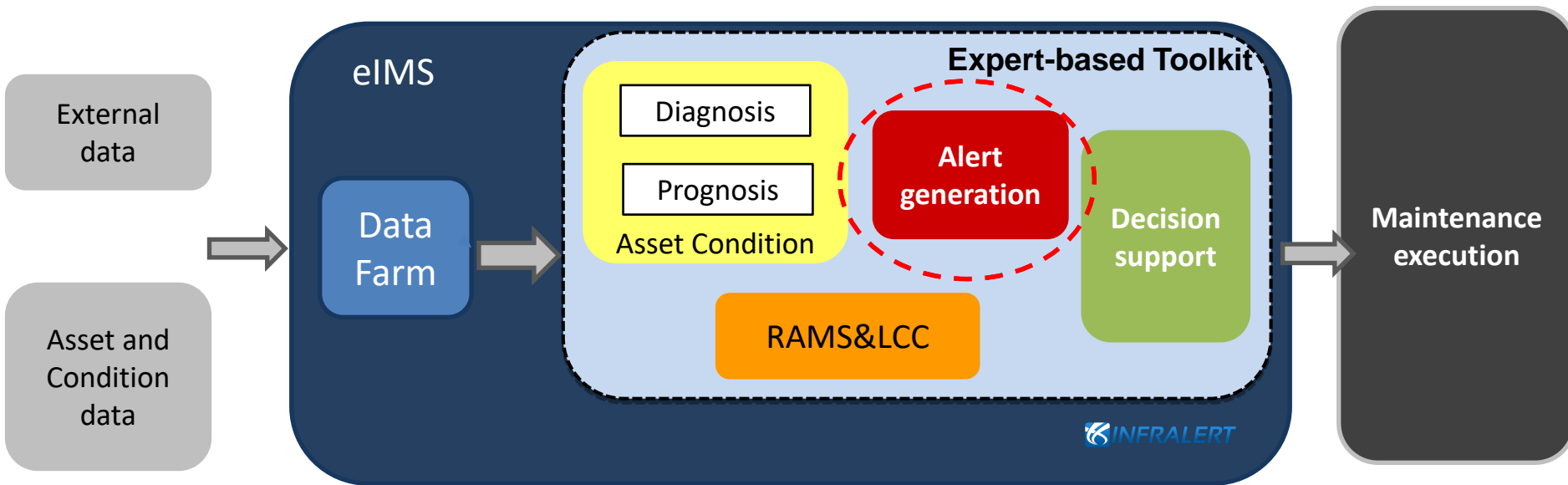
Agenda

- General Overview & Objectives
- Methodological scheme
- Pilot cases & Historical interventions database
- Pilot cases & preliminary results
- On-going conclusions



General Overview & Objectives

Alert management (Alert generation toolkit)



1. To infer **alert levels** for assets based on the state conditions (actual/forecasted).
2. To ascertain the **reliability** of positive alert levels from false positives and false negatives.
3. To prescribe a **level of severity** to all alerts according to the know-how.
4. To **prioritise** all **alerts** according to their level of severity.
5. To recommend an **alert managerial plan** according to post/pre-set criteria.



from
Historical Interventions



prescribed by the
Maintenance Managerial Body



Methodological scheme (i)

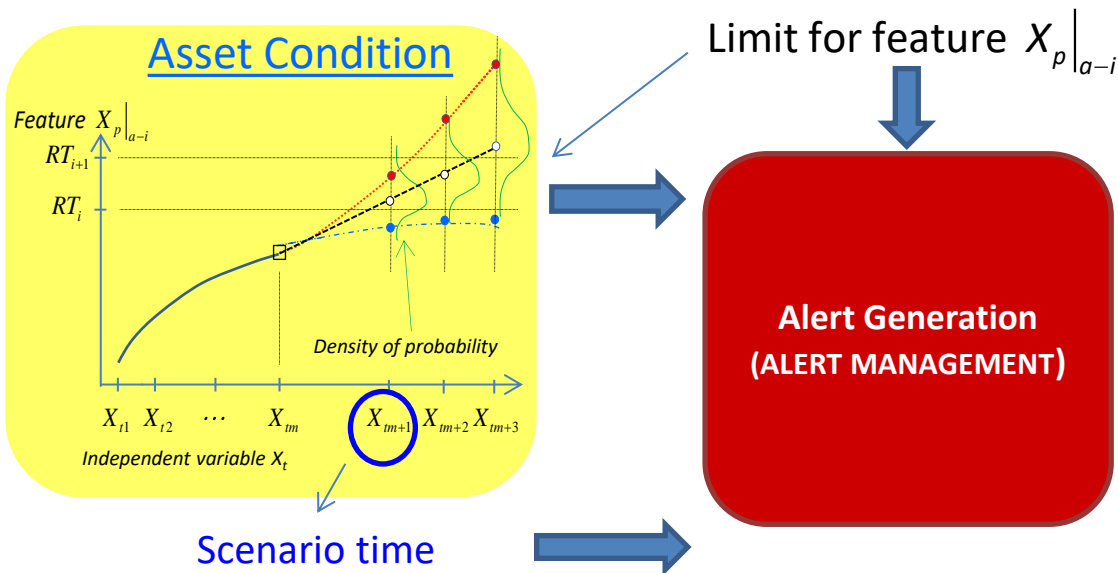
The “Alert management system” analyses/uses:

- present and future asset condition data
- historical maintenance interventions

+



to estimate/predict maintenance alerts.



	Intervention Type	Intervention Reliability		Tech. Severity Levels	Scenario
Asset-Id	WO	FS1	...	TSL1	SC1
Id1	T3.1	90%	...	27	12M
Id2	...	...	...	...	...
	...				
Idm	...	...	...	...	...

Historical database with maintenance interventions

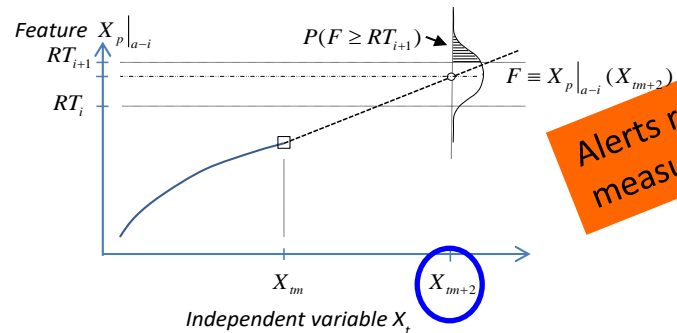
Other User's settings and data:

- Level of confidence γ
- Combinations of features and their related limits
- Measurements



Alert Management

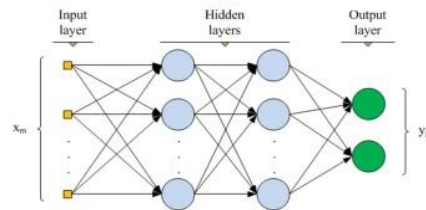
Deterministic/Stochastic level



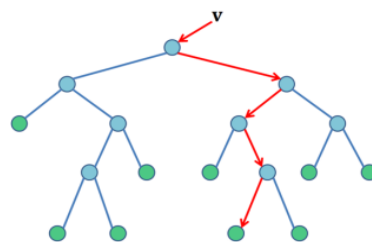
Alerts related to measured/estimated features

$$TSL_1^{(p)} = P(F \geq RT_{i+1}) \geq \gamma \Rightarrow \text{Alert with severity} = TSL_1^{(p)}$$

Machine Learning



Artificial Neural Networks



Artificial Neural Network

Decision Tree

K- nearest neighbours

Support vector machine

Model Fusion

Alerts related to Work Orders

Data Farm

Diagnosis

Prognosis

Asset Condition

Decision support

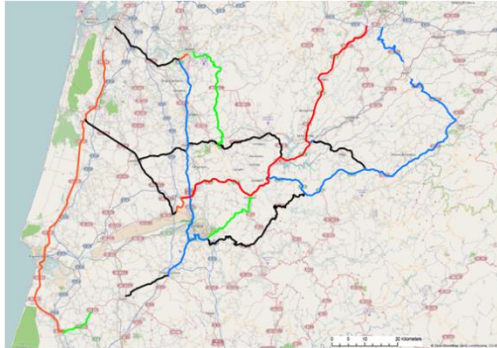


Pilot cases & Historical interventions database



Road Demonstration at Portugal

Road network, Coimbra region in the centre of Portugal, managed by Infraestruturas de Portugal.



Rail Demonstration at Sweden

Rail Demonstration at Railway corridor, Iron Ore Line in Malmbannan in northern Sweden, managed by Trafikverket.



REPOSITORY OF MAINTAINED ASSET

Field name	Description/meaning	Data Type
Asset_Id	Asset identification	INTEGER
Start_node	Starting position	FLOAT
End_node	Ending position (same that Start_node in case the asset identifies with a geometric point)	FLOAT
(All maintenance interventions conducted on Asset Id are reported in following records)		
Maintenance_Id (1)	Maintenance intervention identifier (order number)	INTEGER
...
Maintenance_Id (n)	Maintenance intervention identifier (order number)	INTEGER

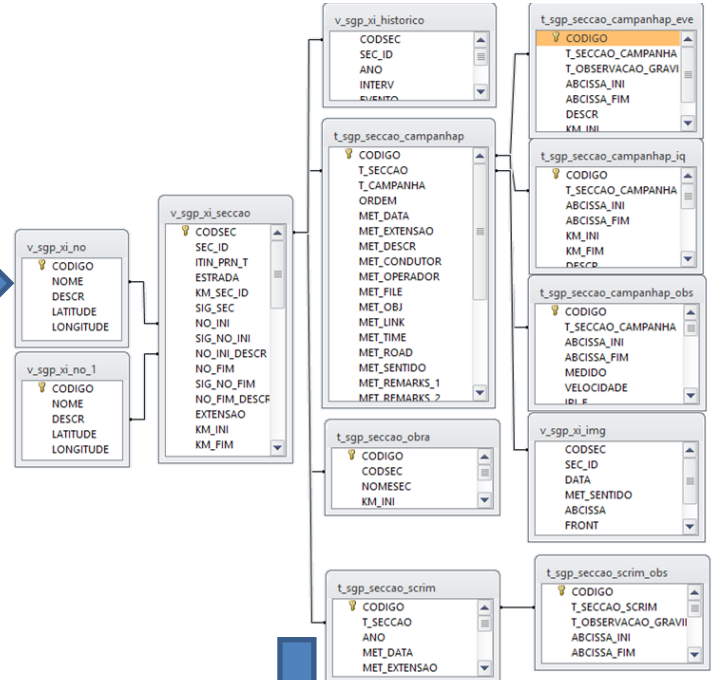
Info provided for the pilot cases

Asset_Id	Start_node	End_node	Maintenance_Id	Start_date
3	48,75	50,771	41	15/06/2013
5	65	65,511	41	15/06/2013
10	74,9	76,101	4	01/01/2015
12	85,45	100,001	33	15/11/2012
12	85,45	100,001	33	15/03/2013
12	85,45	100,001	33	15/06/2013
13	107,495	108,001	33	27/11/2014
14	111	115,2	33	20/11/2014
14	111	115,2	44	22/01/2015
15	111	115,2	33	20/11/2014
27	197,5	198,046	33	15/10/2013
27	197,1	197,697	33	20/09/2014
27	198,5	199,041	33	03/06/2015
28	199,08	206,601	4	01/01/2013





CODIGO	CODESEC	NOMESEC	KM_INI	KM_FIM	VIA	DATA	T_INT
141700	226472	D155	23,56	35,145	A	31/12/2008	CC
141702	237332	D260	83	84,5	A	31/12/2006	CP
141701	226526	D371	0	18,81	A	31/12/2009	CP



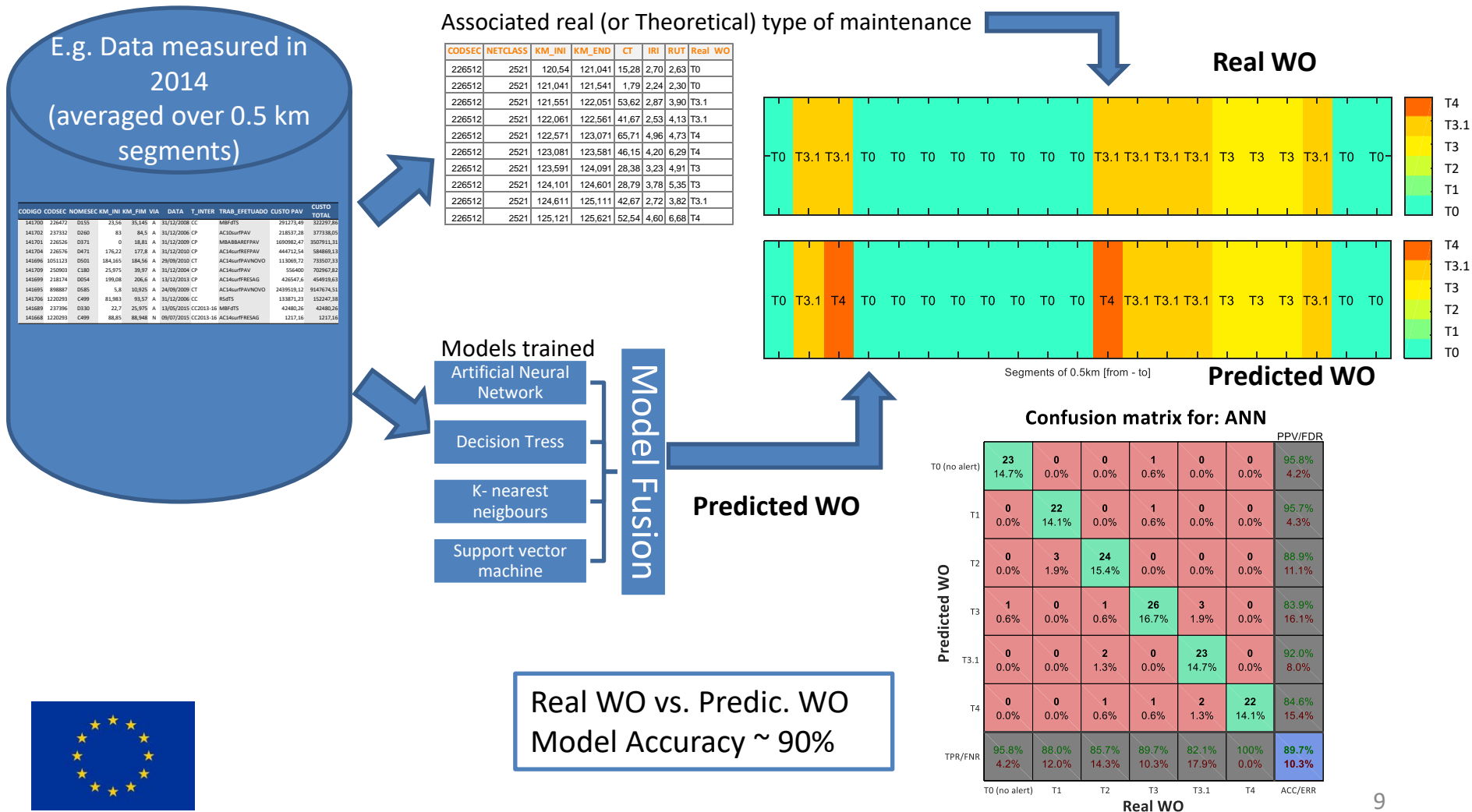
CODIGO	CODSEC	NOMESEC	KM_INI	KM_FIM	VIA	DATA	T_INTER	TRAB_EFETUADO	CUSTO PAV	CUSTO TOTAL
141700	226472	D155	23,56	35,145	A	31/12/2008	CC	MBFDTs	291273,49	322297,56
141702	237332	D260	83	84,5	A	31/12/2006	CP	AC10surfPAV	218537,28	377074,56
141701	226526	D371	0	18,81	A	31/12/2009	CP	MBABBAREFAV	1690982,47	3507911,11
141704	226576	D471	176,22	177,8	A	31/12/2010	CP	AC14surfREFPAV	444712,54	584869,13
141696	1051123	D501	184,165	184,56	A	29/09/2010	CT	AC14surfPAVNOVO	113069,72	733507,33
141709	2509083	C180	25,975	39,97	A	31/12/2004	CP	AC14surfPAV	556400	702967,82
141699	218174	D054	199,08	206,6	A	13/12/2013	CP	AC14surfFRESAG	426547,6	454919,63
141695	898887	D585	5,8	10,925	A	24/09/2009	CT	AC14surfPAVNOVO	2439519,12	9147674,51
141706	1220293	C499	81,983	93,57	A	31/12/2006	CC	RsdTs	133871,23	152247,38
141689	237396	D330	22,7	25,975	A	13/05/2015	CC2013-16	MBFDTs	42480,26	42480,26
141668	1220293	C499	88,85	88,948	N	09/07/2015	CC2013-16	AC14surfFRESAG	1217,16	1217,16

Historical asset features and maintenance interventions
(input for “Alert Management”)



Road case & preliminary results (ii)

- ✓ Model implementation and validation using road features measured



Road case & preliminary results (iii)

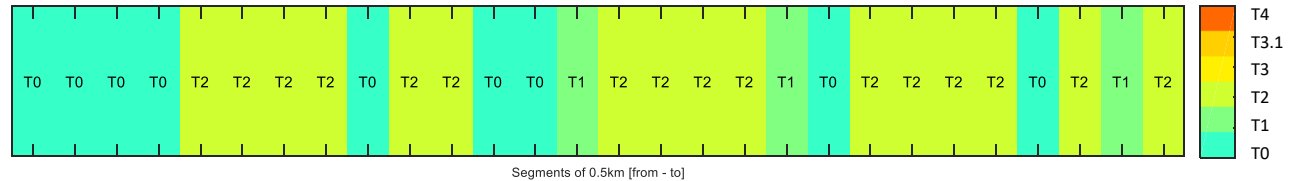
✓ Results for CODSEC 250903 (network class 2522) for year 2014



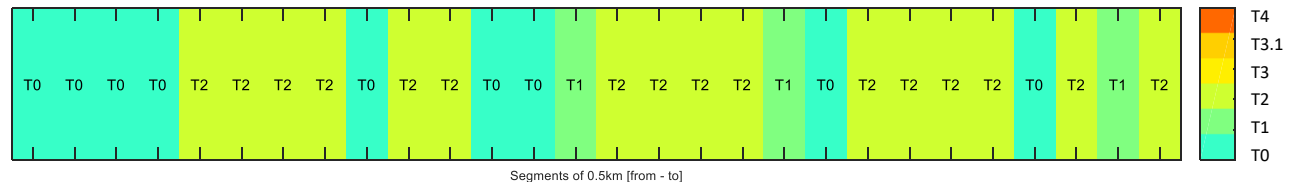
(Source: Google maps; Date: Nov 2014)



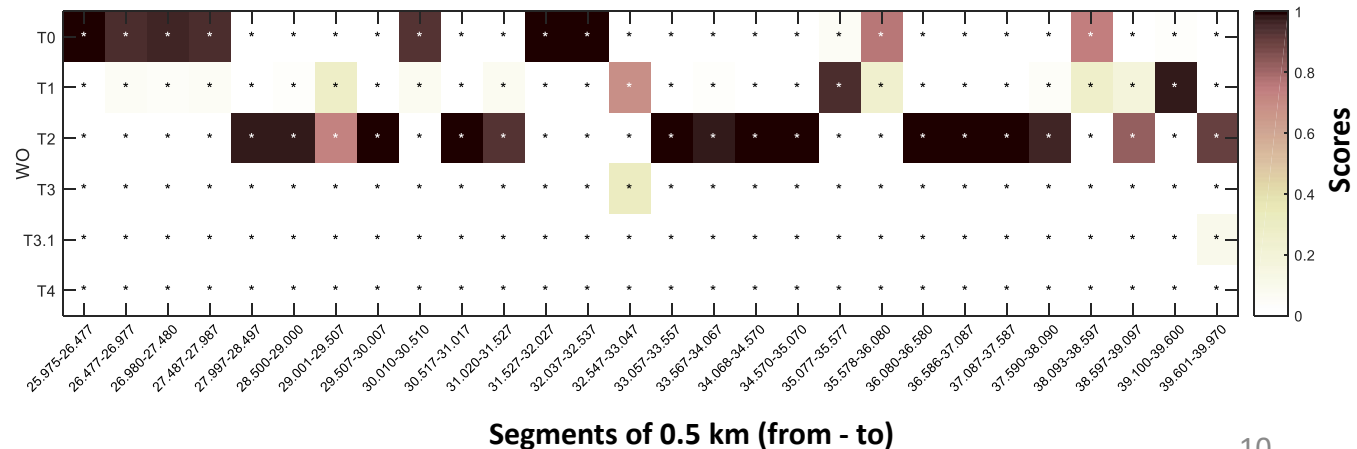
Real WO



Predicted WO




Scores of Predicted WO



- Several Automatic learning (machine learning) methodologies have been generated and proved to work for the Road Pilot case (preliminary results).

 Preliminary conclusion: **Maintenance interventions can be predicted**

- Historical (reported) maintenance interventions are very valuable pieces of information to assess the severity of assets forecasted condition.

 Conclusion: To foster Comprehensive/Exhaustive historical data bases.
(it is the cornerstone of a reliable Maintenance intervention forecast)





www.infralert.eu

Thank you for your kind attention



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