Reducing Maintenance Costs by Adapting Total Asset Management in Japan

International Business Department, NEXCO-Central
Jun Takeuchi

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1. Company Profile

NEXCO-Central

A major P3 player in Japan and has over 60-years experience at every stage of an expressway project such as construction, maintenance, inspection & repair and rest area Management

- Around 10,000 employees*
- 1,286 miles in Operation*
- 1.87 million vehicles per day**
- US$ 5.28 billion of toll revenues**
- US$ 1.52 billion net sales from 180 rest areas**
- Headquarters: Nagoya, Japan

*Data as of April, 2016
**Data as of March, 2014

1. Company Profile

O&M solutions for keeping expressways in a good condition

Toll Collection

- ETC services
- Manual toll collection

Non-ETC lane

ETC lane

Traffic Control

- Traffic Information
- Expressway Patrol

Overloaded truck check

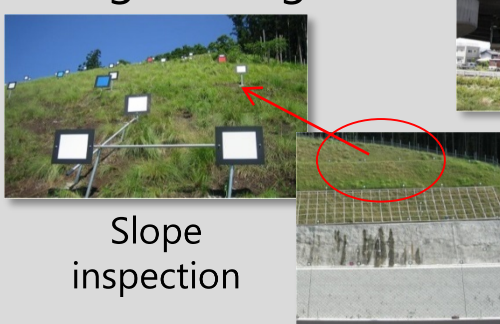
Traffic Control Center

Road patrol

Engineering

- Inspection
- Engineering work

Bridge inspection



Slope inspection

Maintenance

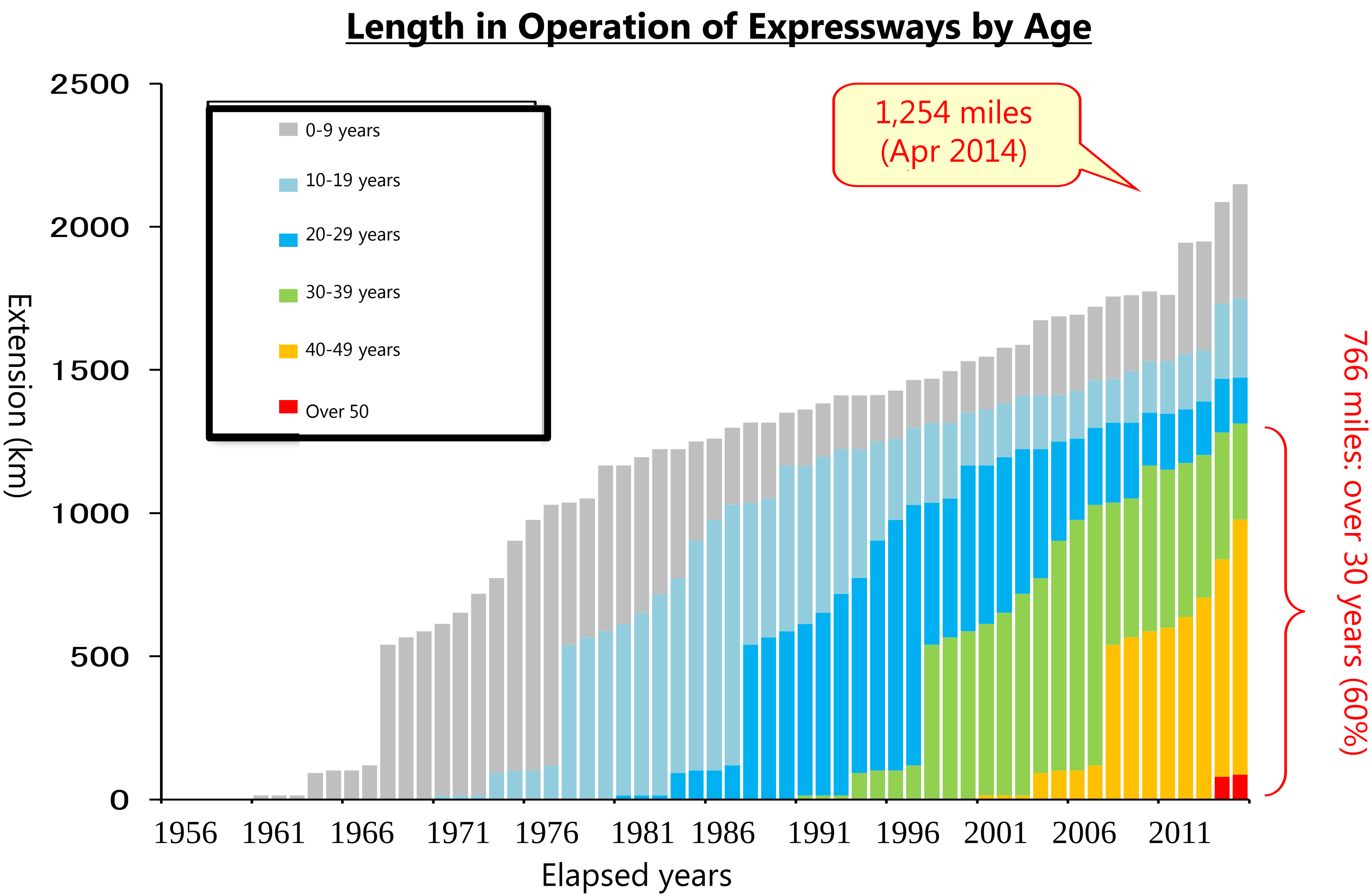
- Repair
- Cleaning
- Landscaping

Lane Closure for maintenance works

Pavement maintenance

O&M: Operation and Maintenance

□ Providing higher quality infrastructures to the society with the lowest possible costs is an eternal task



3. Outline of Our PMS

Supporting tool for building optimized maintenance strategy within budget

NEXCO （HQ･ Branch･ Project Office)

Road surface property data

- Rutting
- Cracks
- IRI

Road profiler

Structure evaluation data

- Damage evaluation of pavement structure by FWD
- Physical test by core sample collection

Road information data

Maintenance history data

Road maintenance

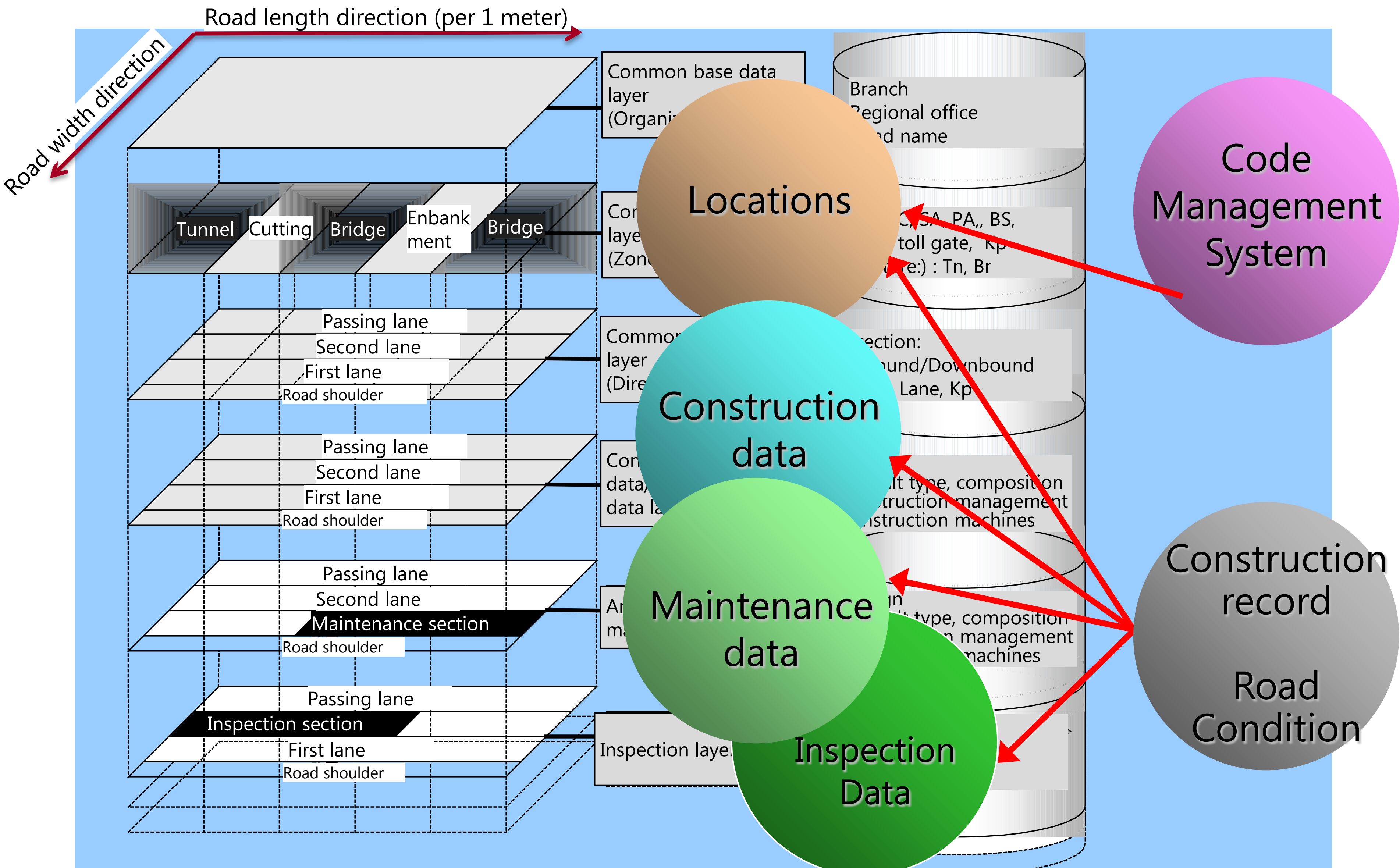
Integrated PMS Database

Support Mid-term/Long-term pavement maintenance strategy

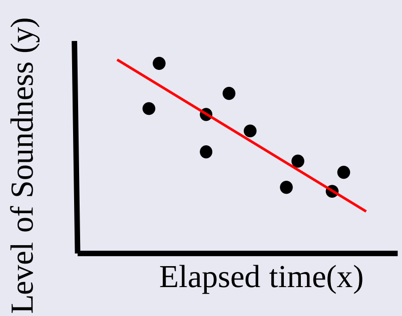
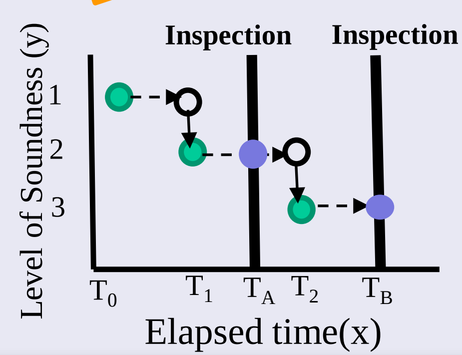
<Past & Present> Evaluate pavement maintenance & Inspection data

<Future> Predict deterioration of pavement

NEXCO-Central PMS database structures(Data layer)



4. Comparison List of Prediction Model

	Regression Anlaysis Model	Dynamic Model	KYOTO MODEL Stochastic Model
Prediction Model	• Regression formula	• Prediction formula with coefficient calibrated	• Prediction on regularity of deterioration process with Markov Model
Merit	• No massive analysis system due to simple mathematical formula	• Available even in case without data organized enough	• Practical with less input data in calculating • Possible for staff without expertise to operate
Demerit	• A relatively large amount of data are required for more accurate regression formula • Inappropriate for decades-long predictions	• Poor usability in operating -Complicated input system -Variety of input data for calibration -Arbitrary parameter setting based on site conditions by an engineer	• A relatively large amount of data are required for more accurate deterioration prediction curve. **Select**
Example		$\Delta R = K_c [\Delta R_1 + \Delta R_2 + \Delta R_3 + \Delta R_4] + \Delta R_5$ K_c: Coefficient calibrated on site R : variable in each element	

5. Characteristics of Our PMS - Kyoto Model-

Kyoto Model

This unique powerful model has been developed to provide accurate maintenance strategies automatically calculated at the network level, by predicting future conditions from only recent less input data regardless of the past ones.

1. **Efficient Deterioration prediction with less input data in calculating**
   - The latest and second latest data
   - Approximately a few items
     - Structure type, Asphalt type, Traffic volume condition, Surface conditions

2. **Benchmarking Evaluation**
   - Compare degree of deterioration by each section
   - Evaluate the degree at the entire network level

3. **Practical pavement maintenance strategy**
   - With budget limitation
   - at network level utilizing benchmarking evaluation

6. How to use data samples

Classification of soundness

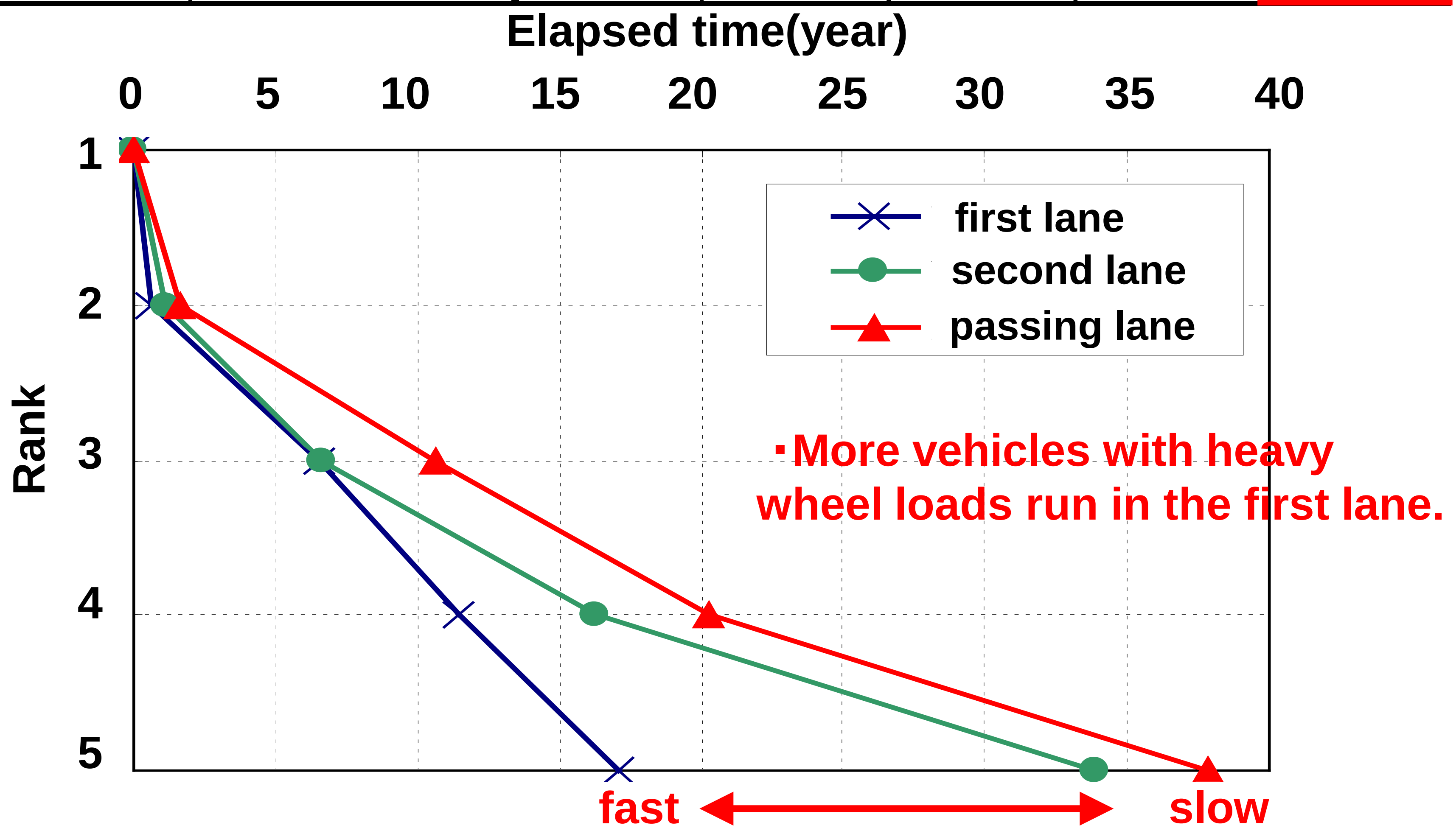
- For example, rutting samples need to be converted into rating value to apply Markov transition probability. It makes the analyzing process simpler,
- As one example, soundness of rutting was classified into 5 rank groupings.

Rating Value

Rank	Amount of rutting
1	Less than 5mm
2	From 5 to less than 10mm
3	From 10 to less than 15mm
4	From 15 to less than 20mm
5	20mm or more

7. Estimation of rut prediction model - Each lane -

	rank	1→2	2→3	3→4	4→5	Total
Life expectancy (year)	first lane	0.66	5.90	4.87	5.61	17.04
	second lane	1.11	5.50	9.66	17.64	33.91
	passing lane	1.64	8.95	9.66	17.64	37.89



8. Forthcoming Challenges

- **Validate accuracy of deterioration prediction**
  - Check the gap between prediction and reality with much experience and accumulated data for inspection & maintenance
- **Allocate budget considering balance of whole road structure conditions**
  - Integrate PMS with other asset management system for building comprehensive maintenance strategy
- **Utilize daily inspection data for PMS**
  - Utilize the number of pothole from daily inspection to find an optimized repair plan at project level

Disseminate Kyoto Model for supporting road operators

- Ensure compatibility with already existing system
- Customize database, input, output based on road operators’ s needs

Continuous promotion of Kyoto model experimental applications

For more details, contact us at international@c-nexco.co.jp








Thank you

Issues & Solutions on Prediction Model

Issues

- **During analysis process**
  - Uncertainty on timing for pavement distress to actually occur
    - » Since pavement is inspected once every 2 year, the actual time when the distress occurs is not grasped. Time difference between inspection time and the actual time generates.
  - Absence of past data
    - » Pavements in a good /poor condition are repaired at the same time by network maintenance planning.

Solutions

Issues	Applied model to our PMS
Uncertainties	Markov deterioration hazard model
Absence of past data	Maximum likelihood estimation with sample dropping bias

KYOTO MODEL

A multi-stage exponential hazard model combing the Markov transition probability