News Release

Railway Technical Research Institute

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RTRI Develops Automated Method for Generating Crew Schedules

The Railway Technical Research Institute (RTRI) has developed a method for automatically generating train crew schedules for timetable revisions (hereafter, “crew schedules”) using a dedicated program, thereby enabling substantial labor-saving and reduction of reliance on specialized skills compared with conventional manual preparation by personnel.

1. Background

- When train timetables are revised, railway operators must prepare crew schedules, which are work plans for crew (drivers and conductors).
- At present, personnel prepare crew schedules manually, taking into account various conditions, including not only train timetables but also the crew’s sign-on and sign-off stations and rules governing on-duty time.
- Because crew schedules are prepared manually, it currently takes personnel several days for each line to complete them.

2. Effects and features of the newly developed method

- By inputting planning conditions such as train timetables and on-duty time into a dedicated program, the method automatically generates efficient crew schedules that satisfy these conditions.
- Case studies confirmed that the crew schedules can be generated within a short time.

Table 1 Time required to generate crew schedules in case studies

Case		Crew	Number of assigned depots	Number of trains (per day)	Time required for generation
Local lines	A	Conductor	1	106	Less than 1 min
	B	Driver	1	129	Less than 1 min
Urban commuter lines	C	Driver	1	433	Approx. 10 min
	D	Driver	3	571	Approx. 5 hr

- Case studies also confirmed that the automatically generated crew schedules require nearly the same number of crew per day as schedules manually prepared by personnel, indicating favorable results.

Table 2 Number of crew required per day in case studies

Case		Conditions	Manually prepared by personnel: number of crew required per day (persons)	Generated by the developed method: number of crew required per day (persons)
Local lines	A	Same as in Table 1	32	32
	B		35	35
Urban commuter lines	C		76	76
	D		205	200

Note: For the number of crew required per day, each crew on an overnight duty is counted as two.

3. Outline of the program

- Crew schedules must be prepared by taking into account more than 30 conditions, including distinctions between the roles of drivers and conductors, train timetables, and on-duty time. Because personnel are currently handling these complex and enormous combinations manually, the task requires highly skilled experts and a great deal of time.
- The dedicated program for automatically generating crew schedules adopts a network optimization method that finds efficient routes within a network represented by nodes and links.
- To apply this optimization method to railway operation, trains that can serve as candidates for crew duties are represented as nodes, and the ranges within which crew can transfer between trains for duty assignments are represented as links (Figure). When the combinations of nodes and links are numerous (for example, Case D, an urban commuter line in Table 1), the number of possible routes can exceed one hundred million, but the program can generate duty diagrams by selecting routes that are efficient from an overall network perspective.
- This program evaluates each route in terms of efficiency and extracts those with higher evaluation scores.

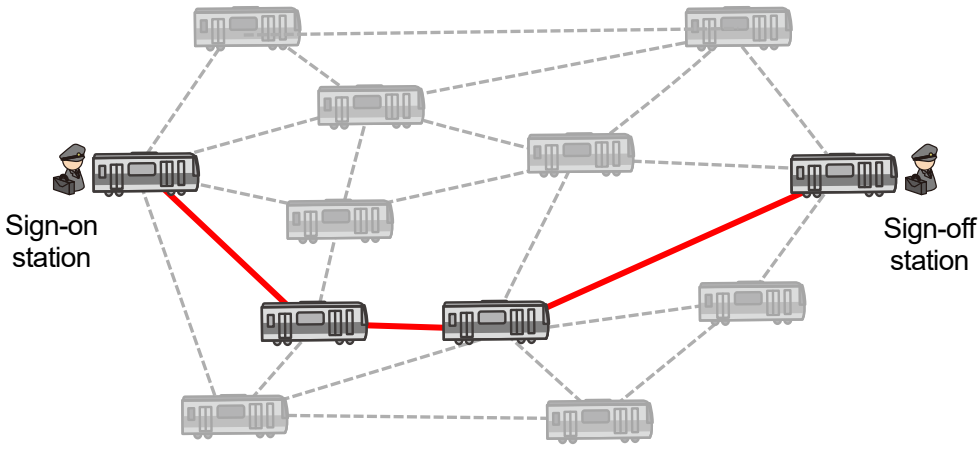

Figure – Conceptual outline of network optimization method

4. Future developments

The developed method is scheduled to be verified by railway operators. The program is intended to be used either as a stand-alone system or as an additional function to systems already in use by railway operators.