



# EFFECTIVENESS OF ANALYSIS OF VISUALIZED SNOW REMOVAL OPERATION RECORDS TOWARD THE ESTABLISHMENT OF SNOW REMOVAL DEPLOYMENT SUPPORT SYSTEM

---

**Kazushige Komiyama**

Researcher, Machinery Technology Research Team  
Civil Engineering Research Institute for Cold Region, Japan



komiyama-k22aa@ceri.go.jp

**Masatoshi Makino, Tetsuya Ogami, Norihito Kishi**

Machinery Technology Research Team  
Civil Engineering Research Institute for Cold Region, Japan

## Outline

---

- 1. Background and objectives**
- 2. Visualization analysis of snow removal operations**
- 3. Simulation of cooperation among adjoining depots**
- 4. Conclusions**

# 1. Background and objectives

---

## In snowy cold regions

- ☒ Snow can greatly hinder road traffic flow
- ☒ Ensuring smooth flow of road traffic is essential

## Road administrators

- ☒ Necessary to conduct efficient and effective snow removal



## 1. Background and objectives

---

### **Efficient and effective snow removal**

- Plan deployments and operations to match snowfall

### **Have not been quantitatively understood**

- Based on past experience & weather forecasts
- Quantitative analysis of deployments and movement



# 1. Background and objectives

---

## Carrying out efficient and effective snow removal

- Detailed analysis and evaluation
  - Snow removal operation
  - Snowfall information



### Developing technology

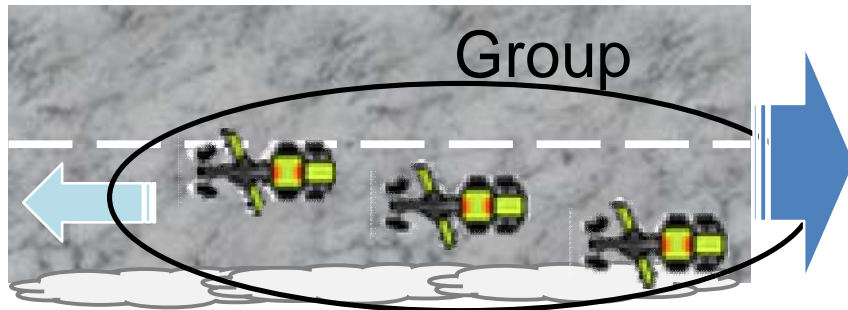
- Deciding The optimal deployments timing
- Provide operations support



**Does not solely depend on empirical decision-making**

## 2. Visualization analysis of snow removal operations

### Using the location data of each snow removers



Snow removal operation (image)

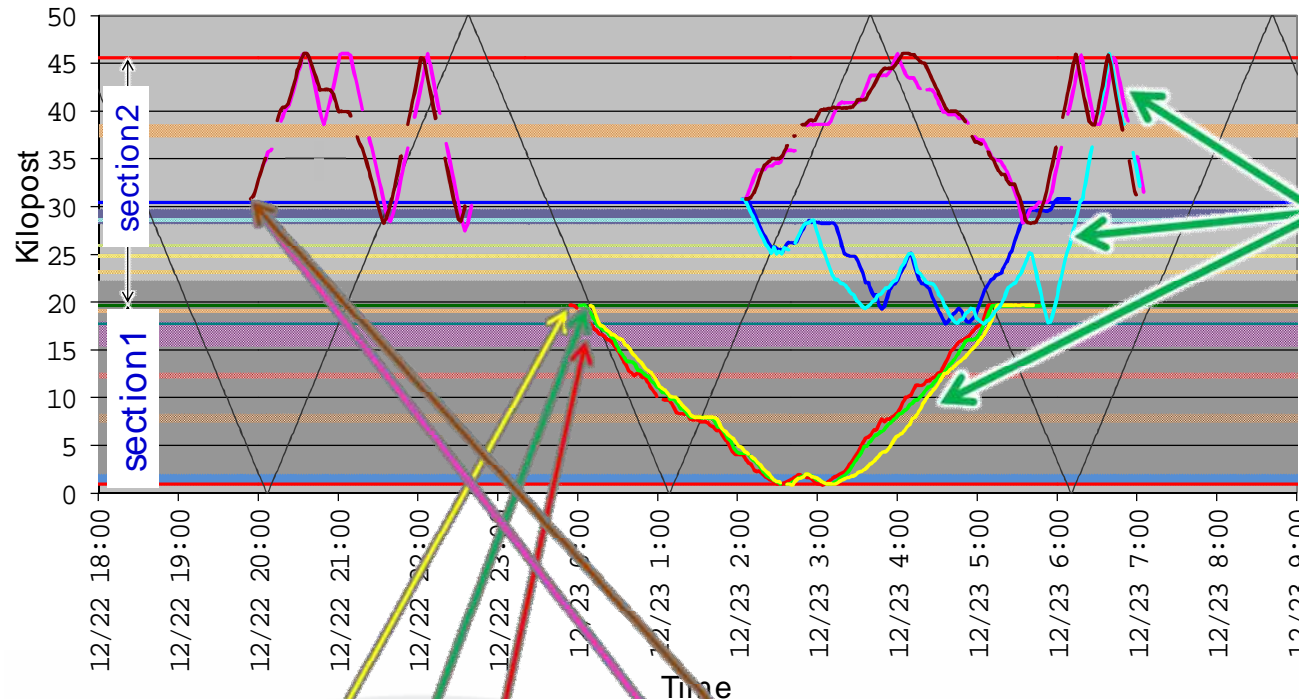
Location and Status data

Operation time	Status	Root	Kilopost	Speed (km/h)
2013/3/11 0:58	Snow removal	R12	8.457	8
2013/3/11 1:00	Snow removal	R12	8.644	5
2013/3/11 1:02	Snow removal	R12	8.950	6
2013/3/11 1:04	Stop	R12	8.989	0
2013/3/11 1:06	Snow removal	R12	9.167	5

**VISUALIZE**

The changes over time in operation routes or formations of a group of snow removers

## 2. Visualization analysis of snow removal operations



[Graph data]

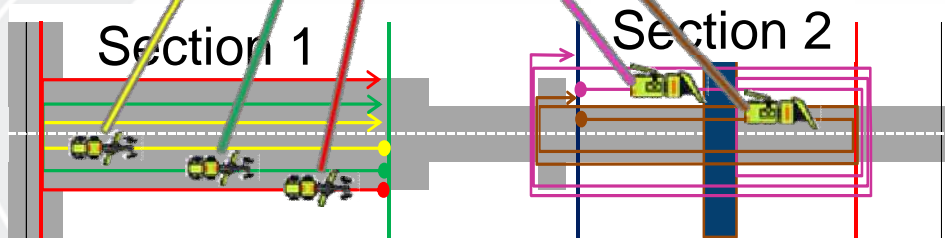
Each colored line shows the movement of one snow removers

Time

[Y-axis]

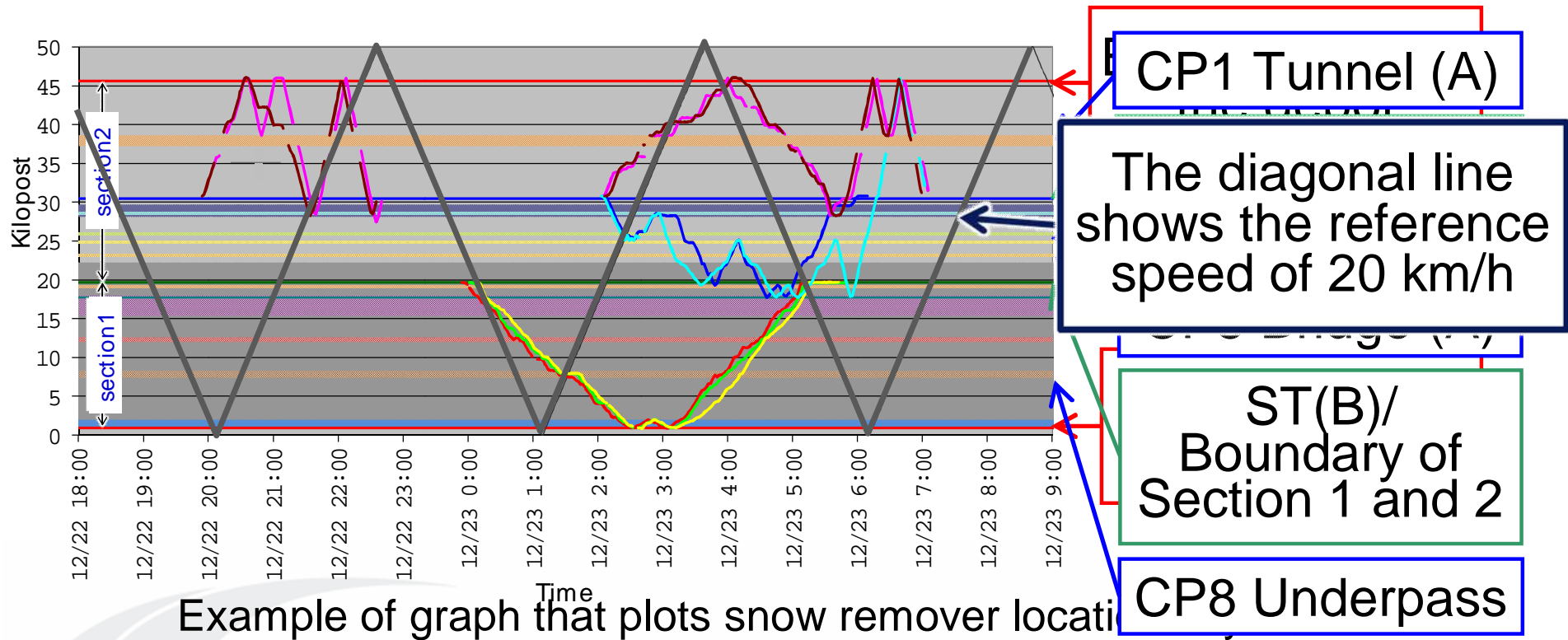
Kilopost (KP)

Example of graph that plots snow remover locations by time



A simple graphic display in above Figure

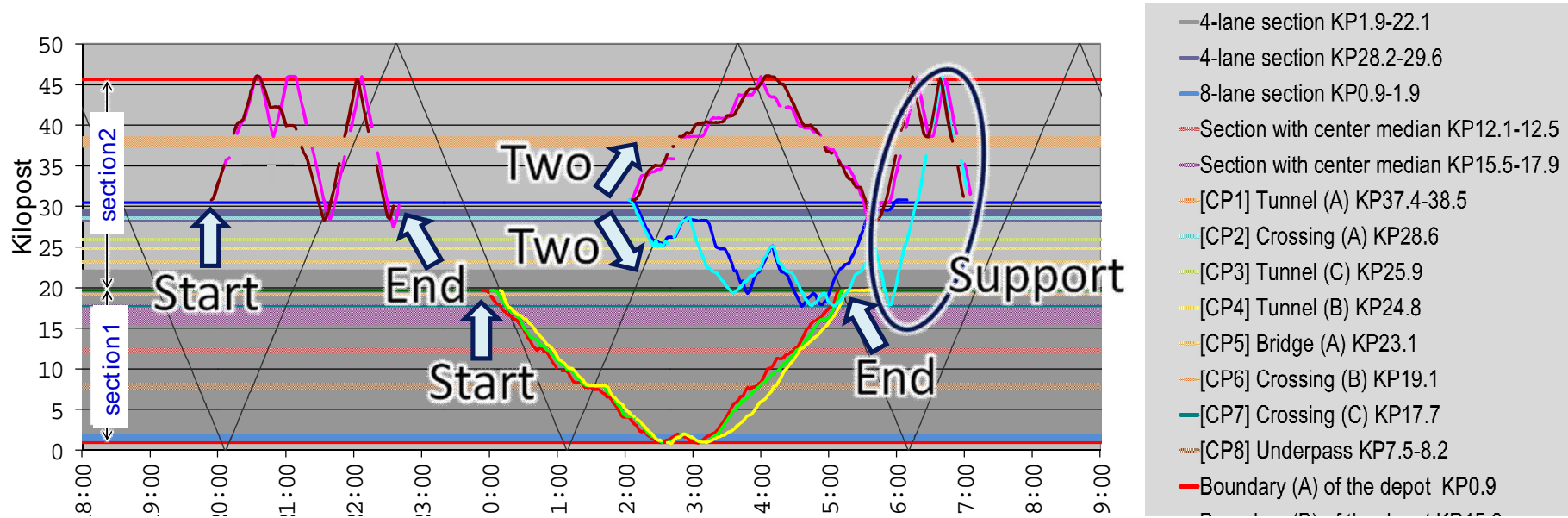
## 2. Visualization analysis of snow removal operations



CP: Control point



## 2. Visualization analysis of snow removal operations



We made simulations of coordinated operation in heavy snowfall.

### 3. Comparison of Ordinary and Heavy snow fall

#### Analysis section

- National highway Route 12 in Sapporo

#### Section information

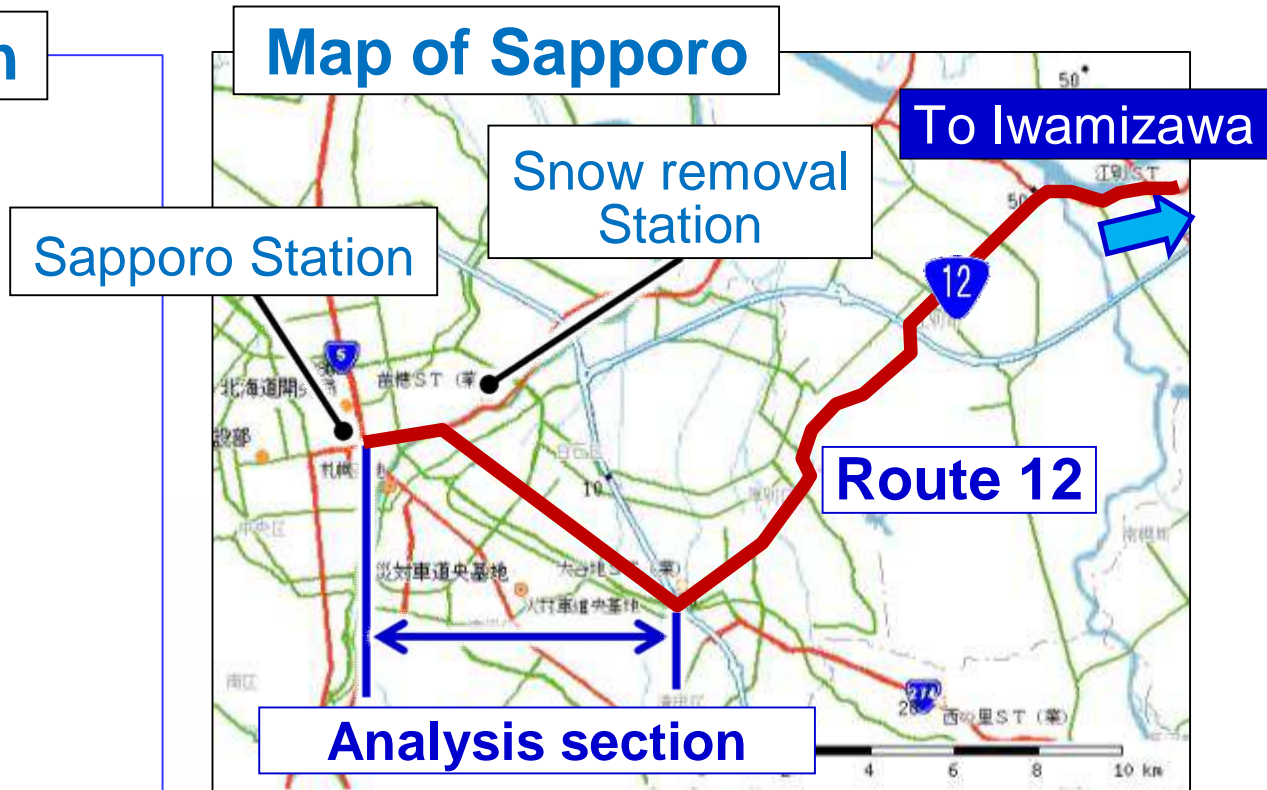
Length  
13.8 km

The Number of snow  
remover

Graders: 3

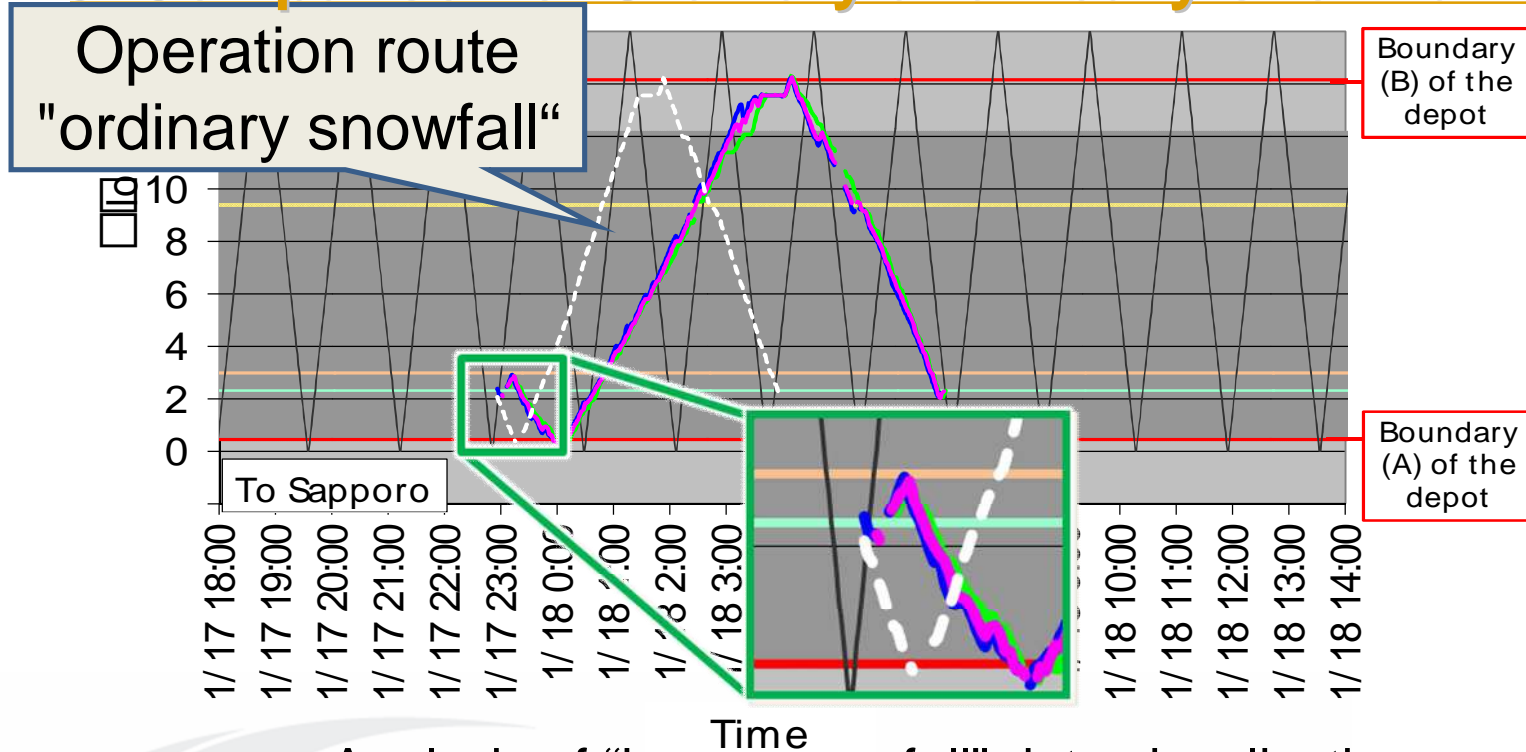


#### Map of Sapporo



Snow removal depot schematic diagram of Route 12

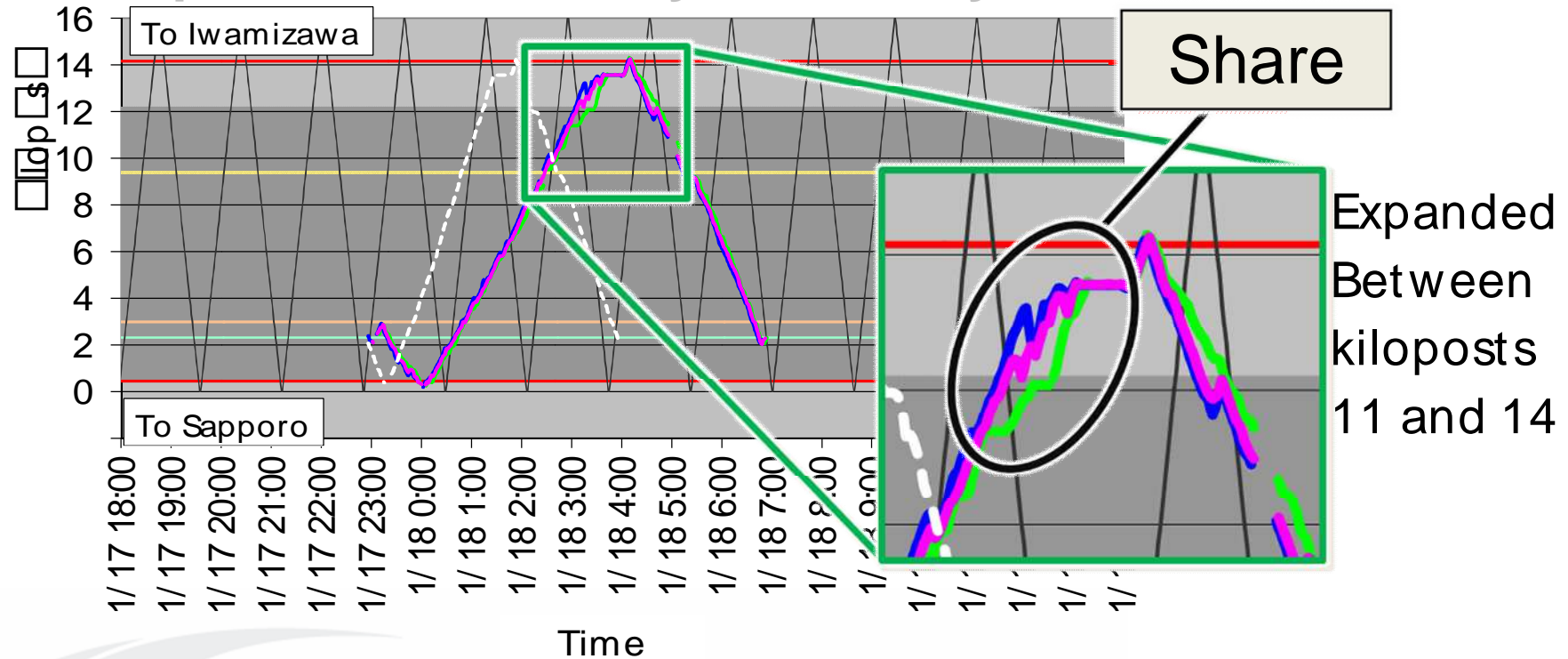
### 3. Comparison of Ordinary and Heavy snow fall



Analysis of “heavy snowfall” data visualization

	Date	Snowfall	Start direction	Operation speed	
				(A) To (B)	(B) To (A)
Ordinary	Dec 31st,2009	9 cm	Upstream	5.4km/h	(A) 7.1km/h
Heavy	Jan 17th,2011	25 cm	Downstream	4.1km/h	(A) 4.9km/h

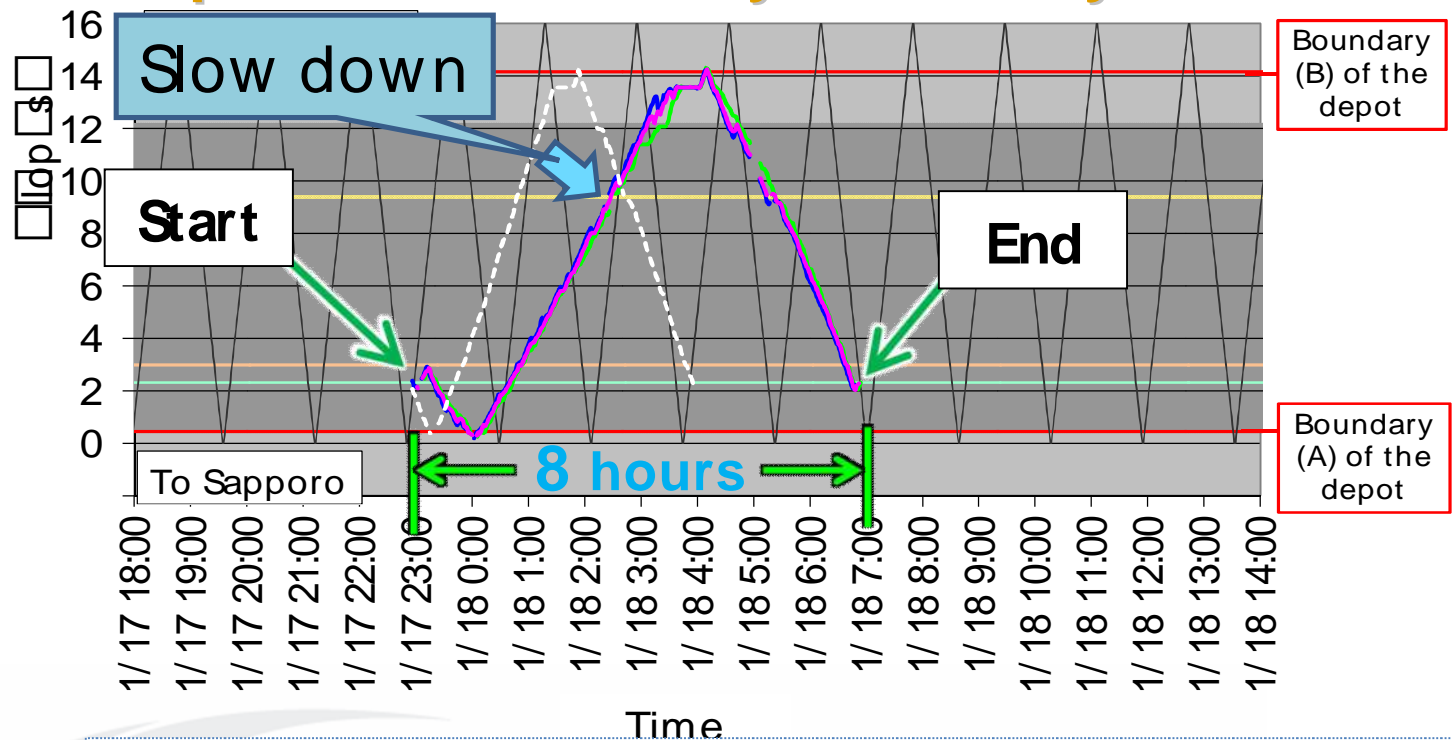
### 3. Comparison of Ordinary and Heavy snow fall



Analysis of “heavy snowfall” data visualization

	Date	Snowfall	Start direction	Operation speed	
				(A) To (B)	(B) To (A)
Ordinary	Dec 31st,2009	9 cm	Upstream	5.4km/h	(A) 7.1km/h
Heavy	Jan 17th,2011	25 cm	Downstream	4.1km/h	(A) 4.9km/h

### 3. Comparison of Ordinary and Heavy snow fall



#### A comparison of ordinary and heavy snowfall.

- A group of snow removers was divided
- Operation routes were changed
- The travel speeds were lower under heavy snowfall conditions

Ordinary	Jan 17th, 2011	25 cm	Downstream	4.1 km/h	(A) 4.9 km/h
Heavy	Jan 17th, 2011	25 cm	Downstream	4.1 km/h	(A) 4.9 km/h

## 4. Simulation from Visualized Data Analysis

### **Snow removal operation of ordinary snowfall**

- Only remove snow within the road section of responsibility

### **Heavy snowfall in a narrow**

**region** Consider redeployment on the same route if an operation is lagging behind.

- The route cannot secure a stable travel speed.
- Equalization of snow removal operation times on the same route is most desirable



- Cooperative snow removal by adjoining depots is effective.

## 4. Simulation from Visualized Data Analysis

### Snow removal operation of ordinary snowfall

- Only remove snow within the road section of responsibility

### Heavy snowfall in a narrow region

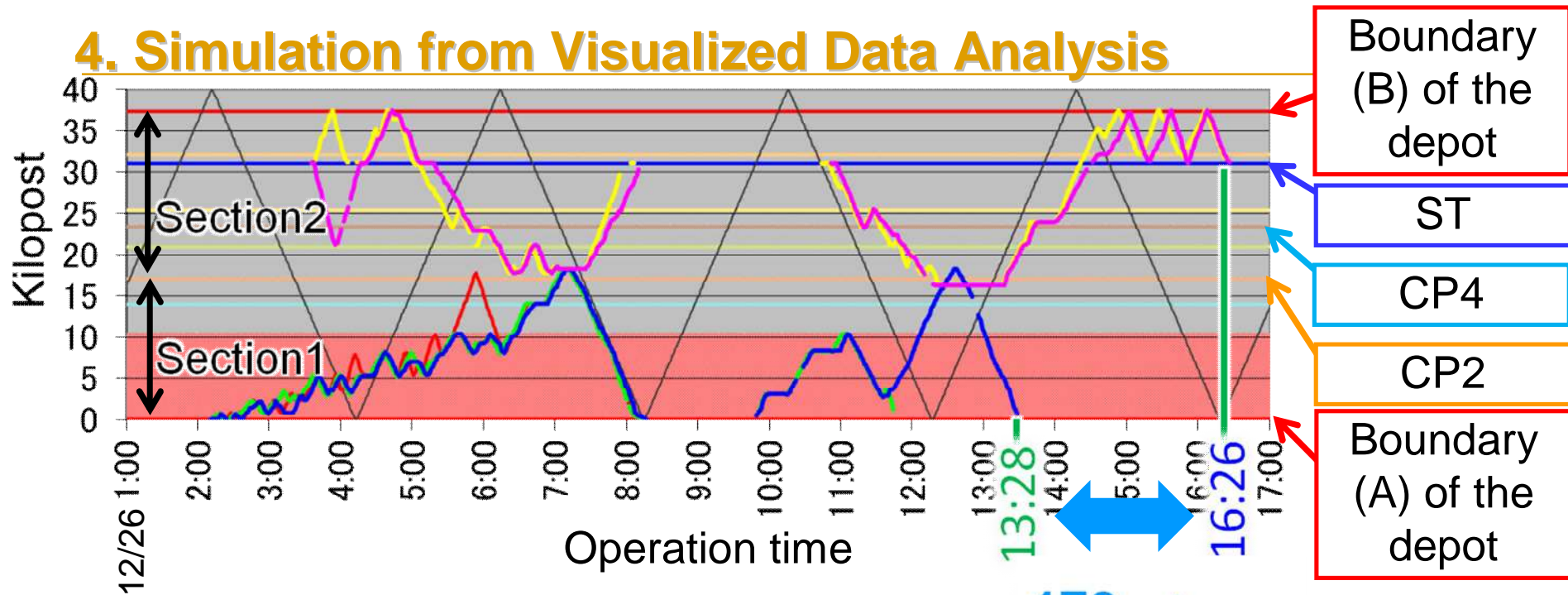
Consider redeployment on the same route if an operation is lagging behind.

- The route cannot secure a stable travel speed.
- Equalization of snow removal operation times on the same route is most desirable

#### What's cooperative snow removal among adjoining

- A vehicle extending the turnaround point into the zone of the lagging depot.
- A vehicle leaves its group and removes snow on the route of the lagging depot.

## 4. Simulation from Visualized Data Analysis



Snow removal operation situatio **178 mins**

### [ Completed time ]

Section 1 ----- 13:28

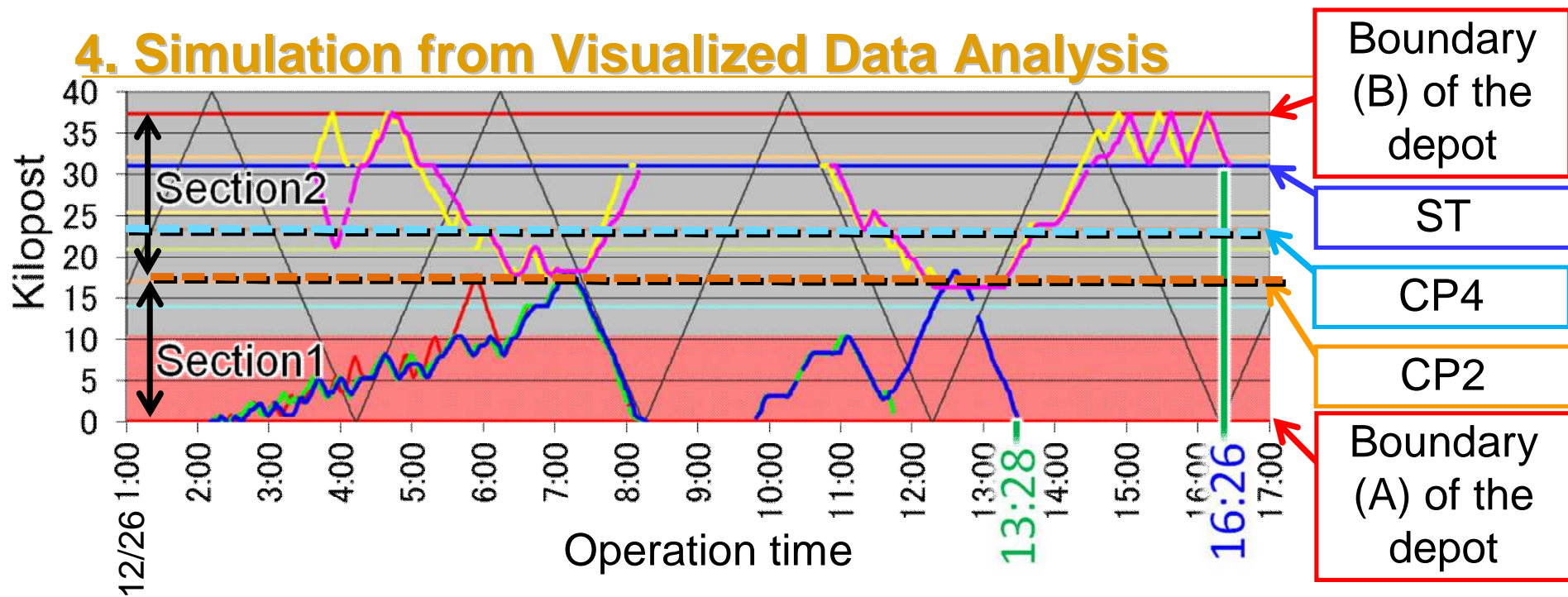
Section 2 ----- 16:26

Time difference ----- 178 minutes

(between section1 and 2 completion time)



## 4. Simulation from Visualized Data Analysis



Snow removal operation situation

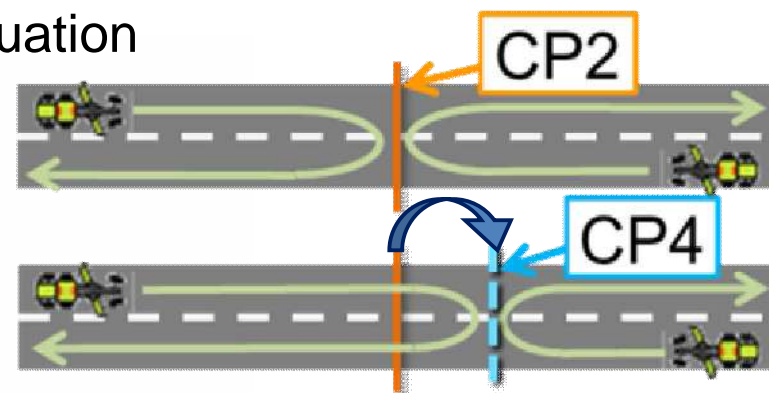
[ Simulation ]

Moved the boundary between the two sections from **CP2** to **CP4**.

**CP2** : Boundary of Section 1 and 2

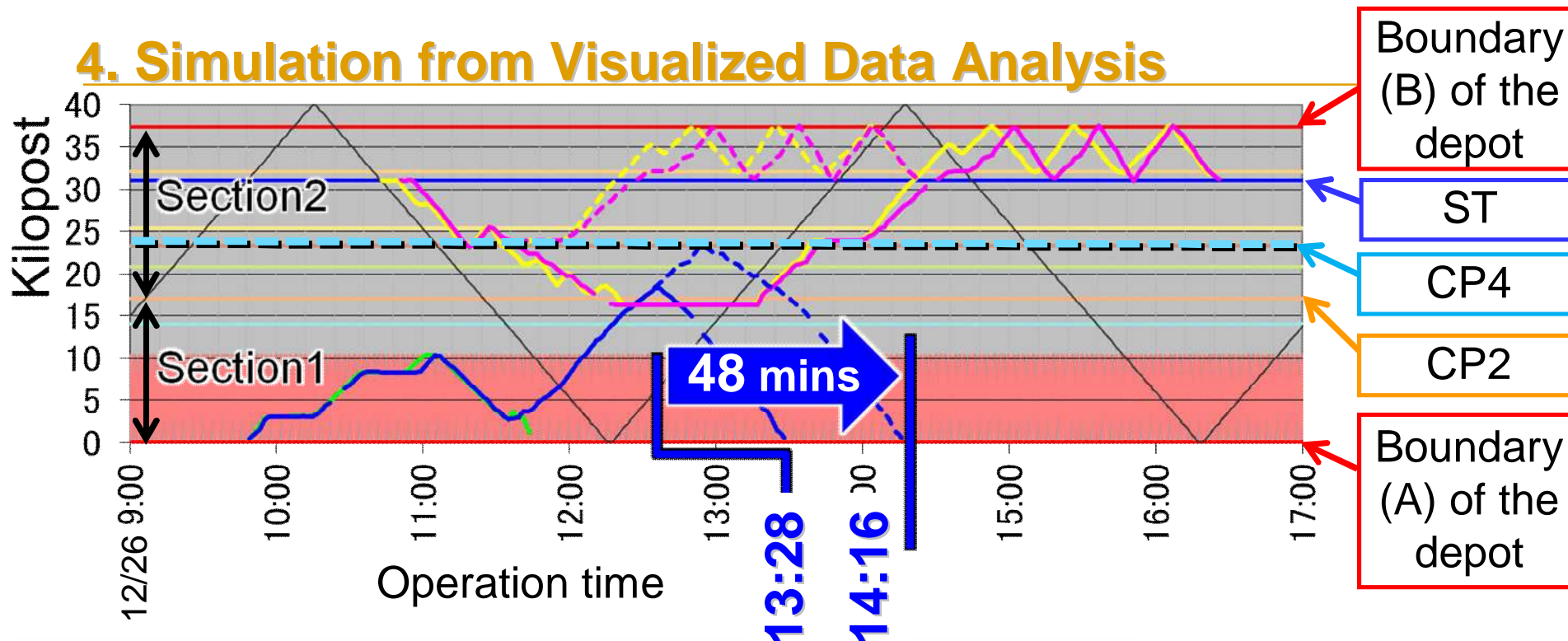
**CP4** : Bridge(B)

(Snow removers turn point)



Moved the boundary section (image)

## 4. Simulation from Visualized Data Analysis



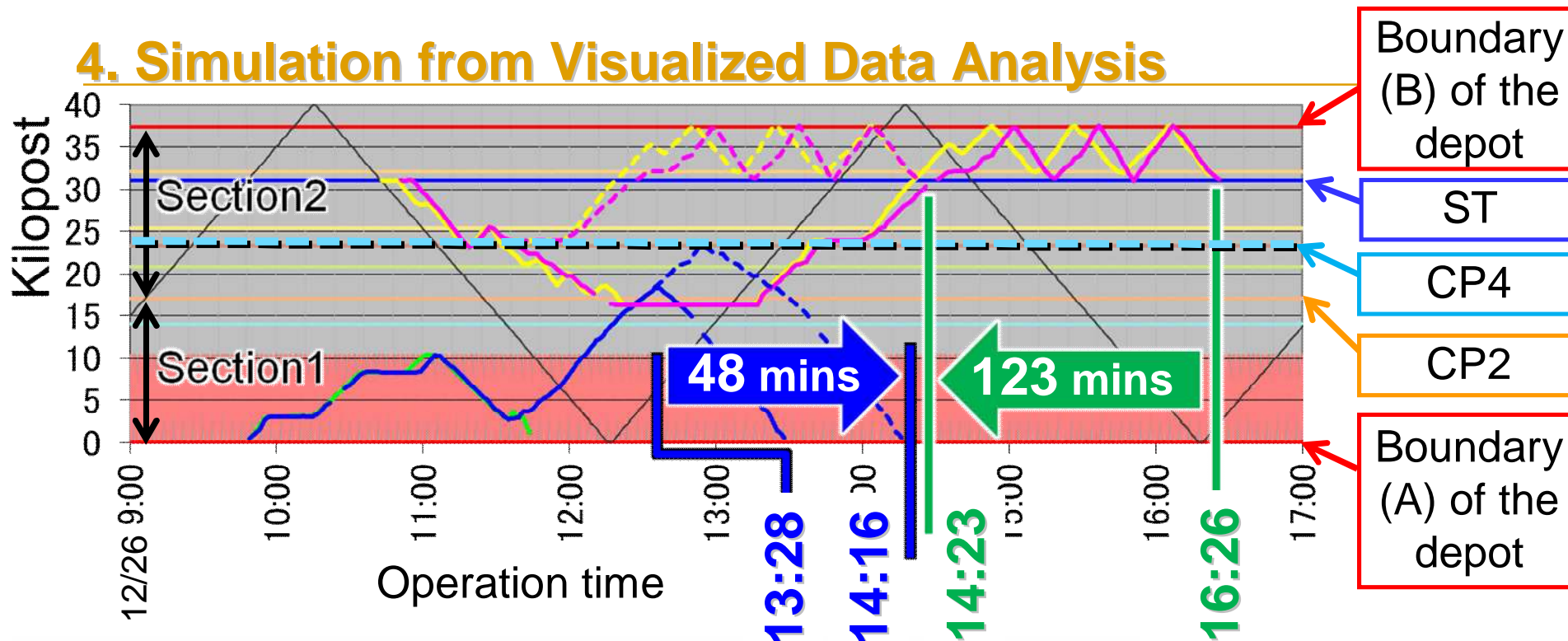
Simulation: Boundary between two sections when shifted to CP4

[ Completed time ] [ Simulation Results ]

Section 1 --- 13:28 → 14:16 (48 mins longer)

Section 2 --- 16:26

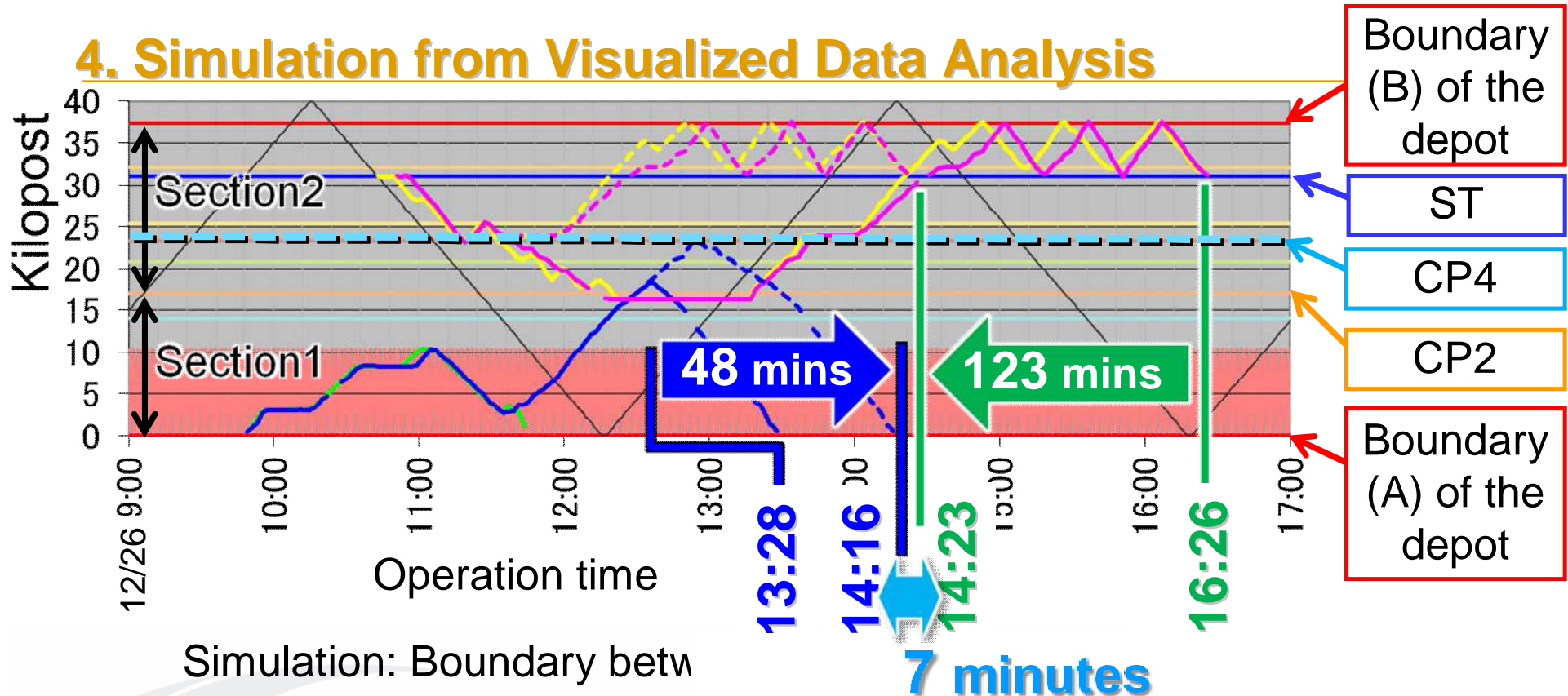
## 4. Simulation from Visualized Data Analysis



Simulation: Boundary between two sections when shifted to CP4

[ Completed time ]	[ Simulation Results ]
Section 1 --- 13:28	14:16 (48 mins longer)
Section 2 --- 16:26	14:23 (123 mins shorter)

## 4. Simulation from Visualized Data Analysis



### Make a simulation by using a visualization analysis

- The expected locations of each snow remover, along with the time and the expected completion times on both sections.
- The difference in snow removal completion times between adjoining snow removal road sections.
- The effectiveness of cooperative snow removal between adjoining snow removal road sections.

## 5. Conclusions

---

### Visualization analysis of snow removal operations

#### Easily check

- Changes in organization/formation of groups
- Snow removal operation routes(each snow removers)
- Progress of the snow removal for adjoining depots

#### Can also be used for

- Post-operation analysis of inefficient operation factors
- Reviewing
  - Snow removal operation route plans
  - Snow remover organization/formation plans
- Deciding effective depot cooperation by real-time simulation when heavy snowfalls

## 5. Conclusions

---

### Future Considerations

#### Our future study

- Analyze the relationship between snowfall conditions and snow removal methods.

#### Visualized data analysis technology

- Establish a decision-making system
  - optimal deployment timing
  - snow removal operation support

**We hope to contribute to more effective snow removal!**



**Thank you for listening**