

**PURDUE**  
UNIVERSITY

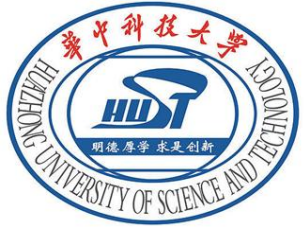


# Using STAMP to analyze serious accidents in China railway system

Liu Hong

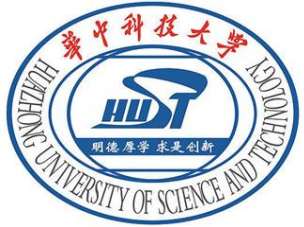
Huazhong University of Science and Technology, China  
Nextrans Center, Purdue University

2013.03.27



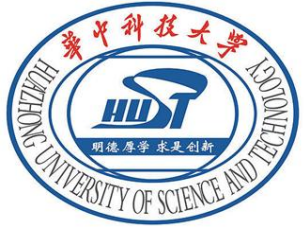
# China railway system

- Total railway operating length: 98,000KM (At the end of 2012)
- Passenger: 1.61 billion (2012)
- Goods: 3.3 billion tons (2012)
- High-speed rail: 13,000KM, about 300km/h



# China railway accidents

Time	Location	Train	Fatalities	Injuries	Accidents
04/11/2006	Linzai - Dongshui	T159, 1017	2	18	Collide
02/28/2007	Zhenzhuquan - hongshanqu	5807	3	34	Derail (Wind)
01/23/2008	Anqiu - Changyi	D59	18	9	Collide Workers
<b>04/28/2008</b>	<b>Zhoucun - Wangcun</b>	<b>T159, 5034</b>	<b>72</b>	<b>416</b>	<b>Derail, Collide</b>
<b>07/23/2011</b>	<b>Yongjia - Wenzhounan</b>	<b>D301, D3115</b>	<b>40</b>	<b>192</b>	<b>Rear-end, Derail</b>



# STAMP-based analysis - Jiaoji

Safety Science 48 (2010) 544–555



Contents lists available at [ScienceDirect](#)

Safety Science

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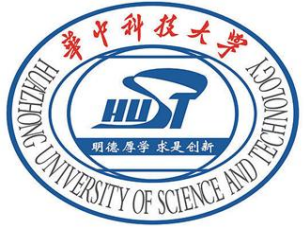


STAMP-based analysis on the railway accident and accident spreading: Taking the China–Jiaoji railway accident for example

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# China-Jiaoji railway accident

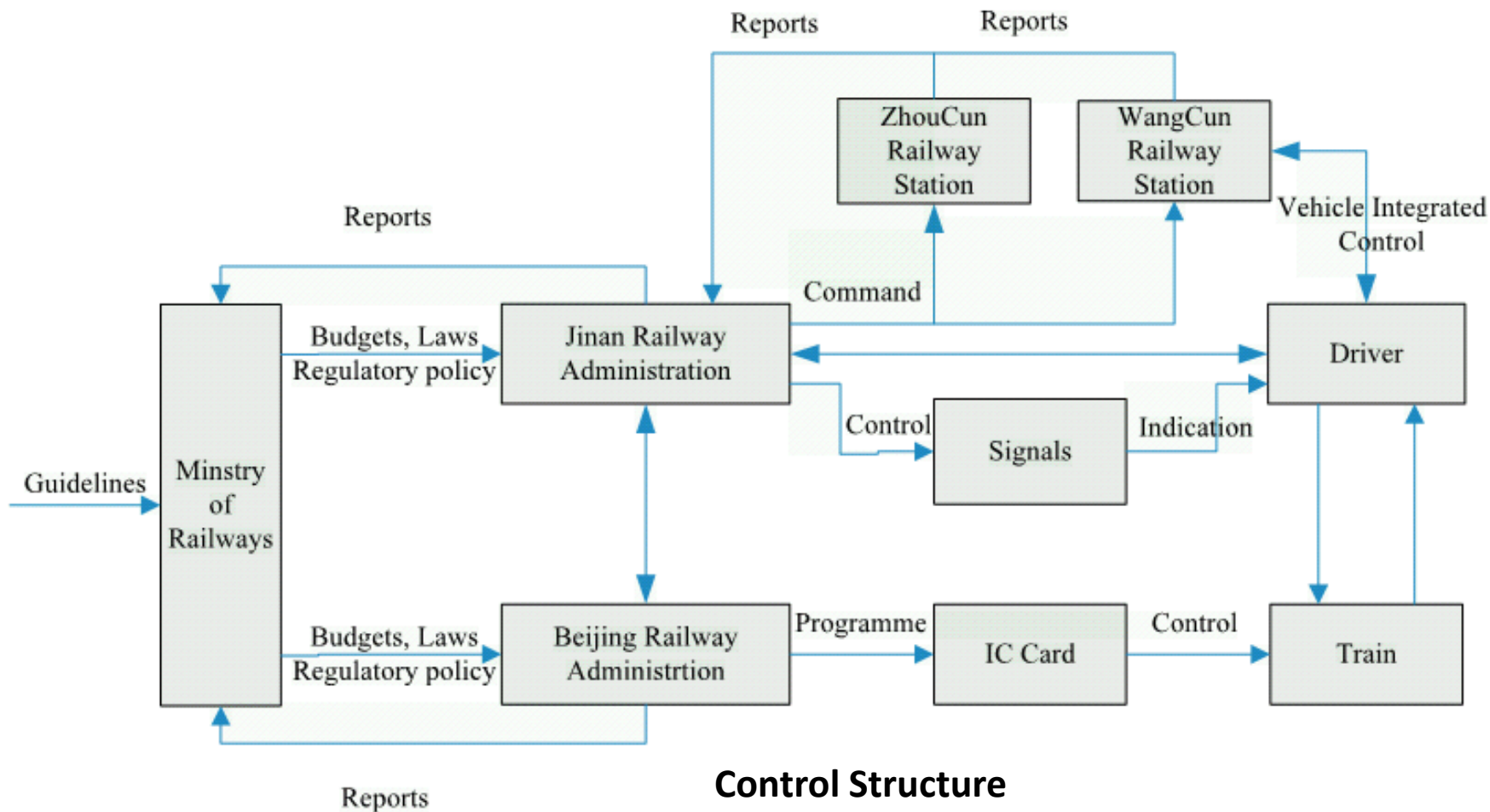
- A serious railway accident on April 28, 2008. The accident caused 72 fatalities and 416 injuries.
- 04:38, Train T195 derailed on the inside track because of over speed. (The first stage)
- 04:41, Train 5034 collided T195 from the other direction on the outside track. (The second stage)

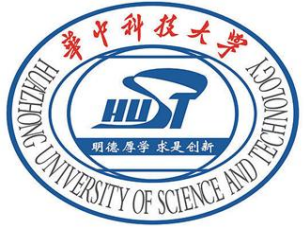
**System Hazard:** Train derails.

**System Safety Constraints:** The safety control structure must prevent derailment of the train.

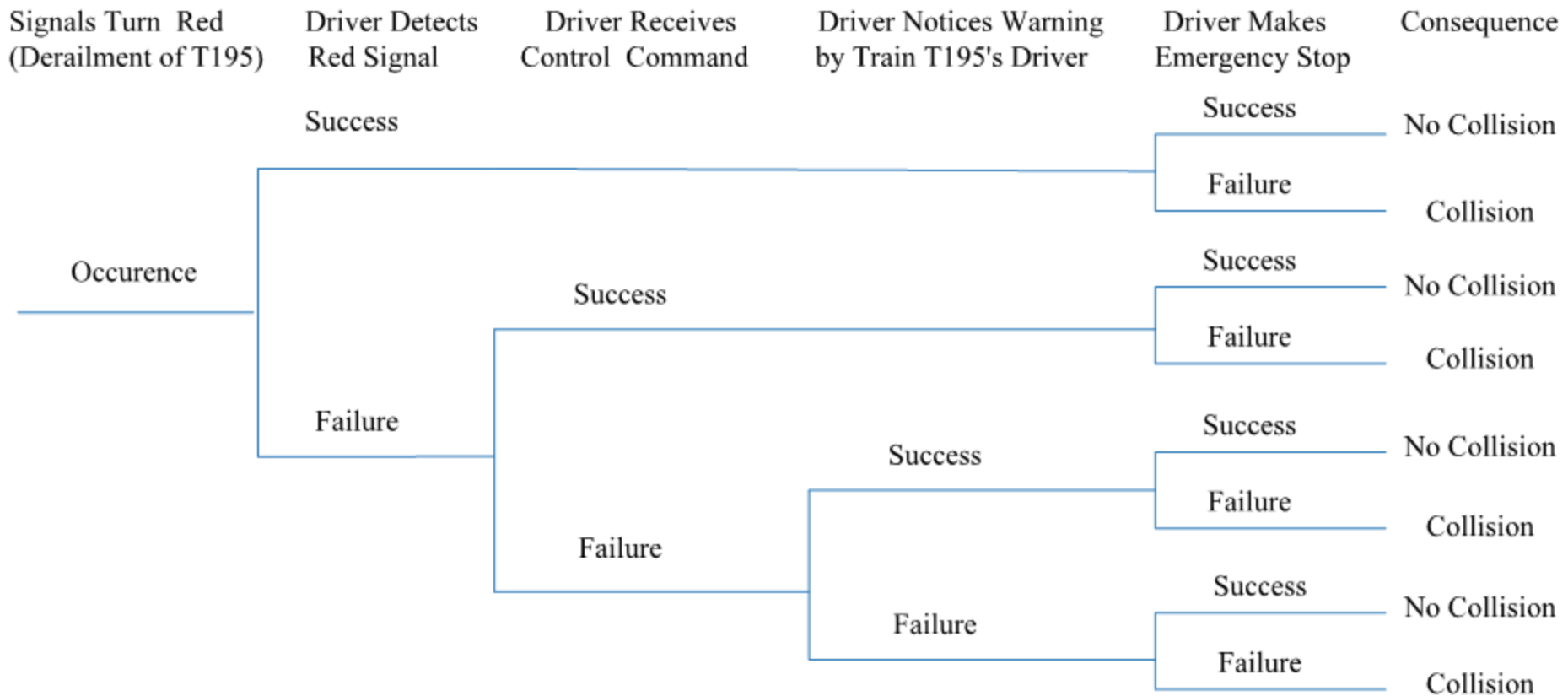
(1) Train must run within limited speed.

(2) Driver must know the correct limited speed through different kinds of ways(e.g. IC cards and the scheduler).

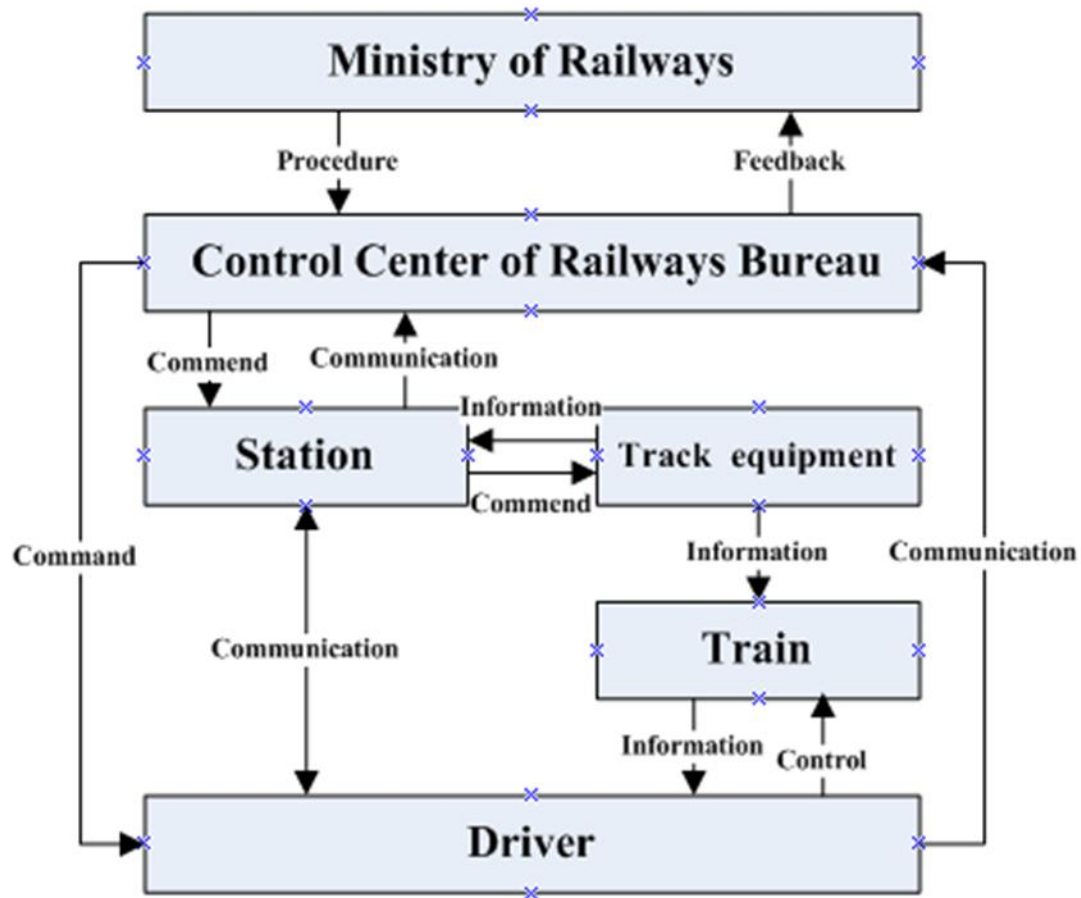




# The spread of the first accident



**Event sequences for the collision after the derailment of train T195**



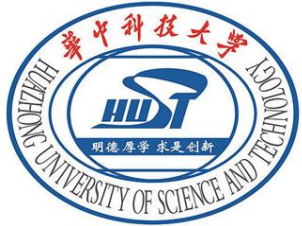
**The hierarchical control structure of trains in china**





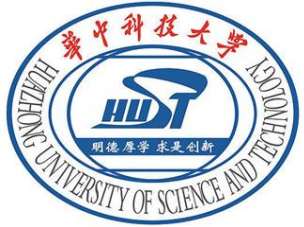
# Difficulty

- We need more elaborate control structures to analyze based on STAMP.
- It is hard and heavy workload to describe all the control structures of each subsystems. Not all the control structures will be used during the analysis.
- How to organize the reasons found through STAMP and propose corresponding improvement methods?

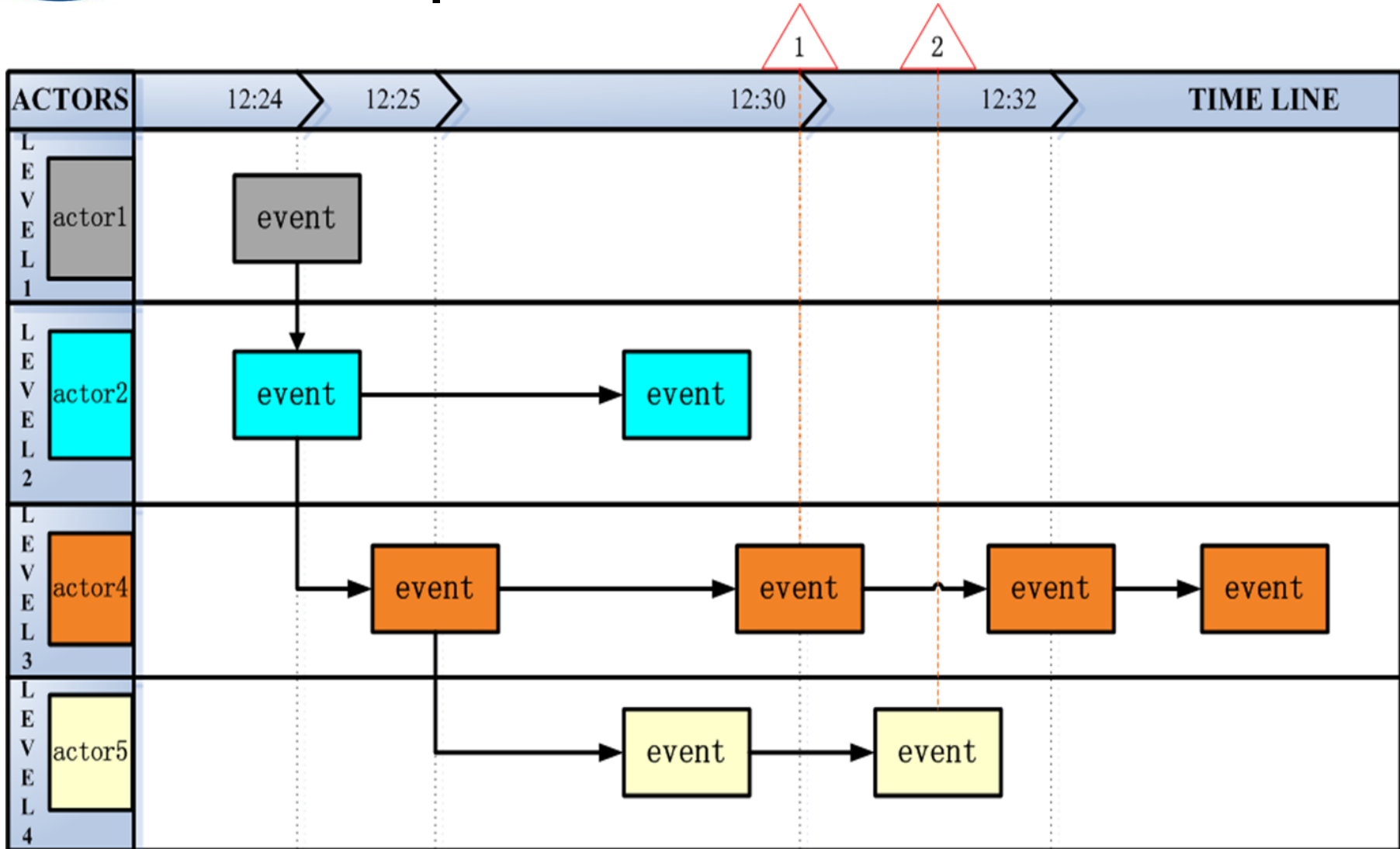


# STEP

- STEP: the Sequentially Timed Events Plotting method (Hendrick & Benner, 1987);
- a multi-linear event **sequence** models and methods;
- STEP provides a comprehensive framework for accident investigation from the description of the accident process



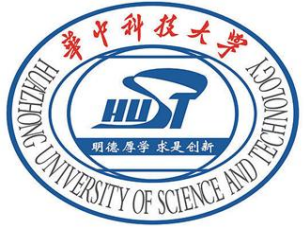
# Graph based on STEP





# STEP - STAMP

- (1) Collecting data, and use natural language to record the process of an accident.
- (2) Use graph to describe the accident, and mark the wrong events in the graph (STEP).
- (3) Construct control structures based on wrong events and use STAMP to analysis.
- (4) Classify the reasons of the accident, and propose the preventions and improvement methods.

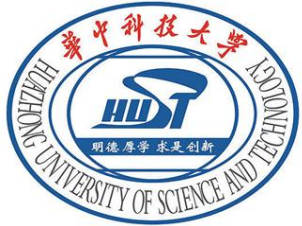


# Yongwen (7.23) railway accident

- Another serious railway accident on July 23, 2011. The accident caused 40 fatalities and 192 injuries.
- 20:30, Train D301 from Beijing to Fuzhou rear-ended train D3115 from Hangzhou to Fuzhou.
- The two trains derailed, and four cars fell off the viaduct.

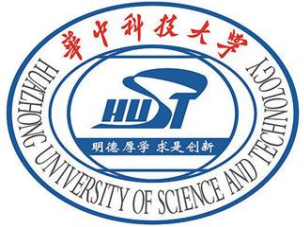
# Yongwen railway accident



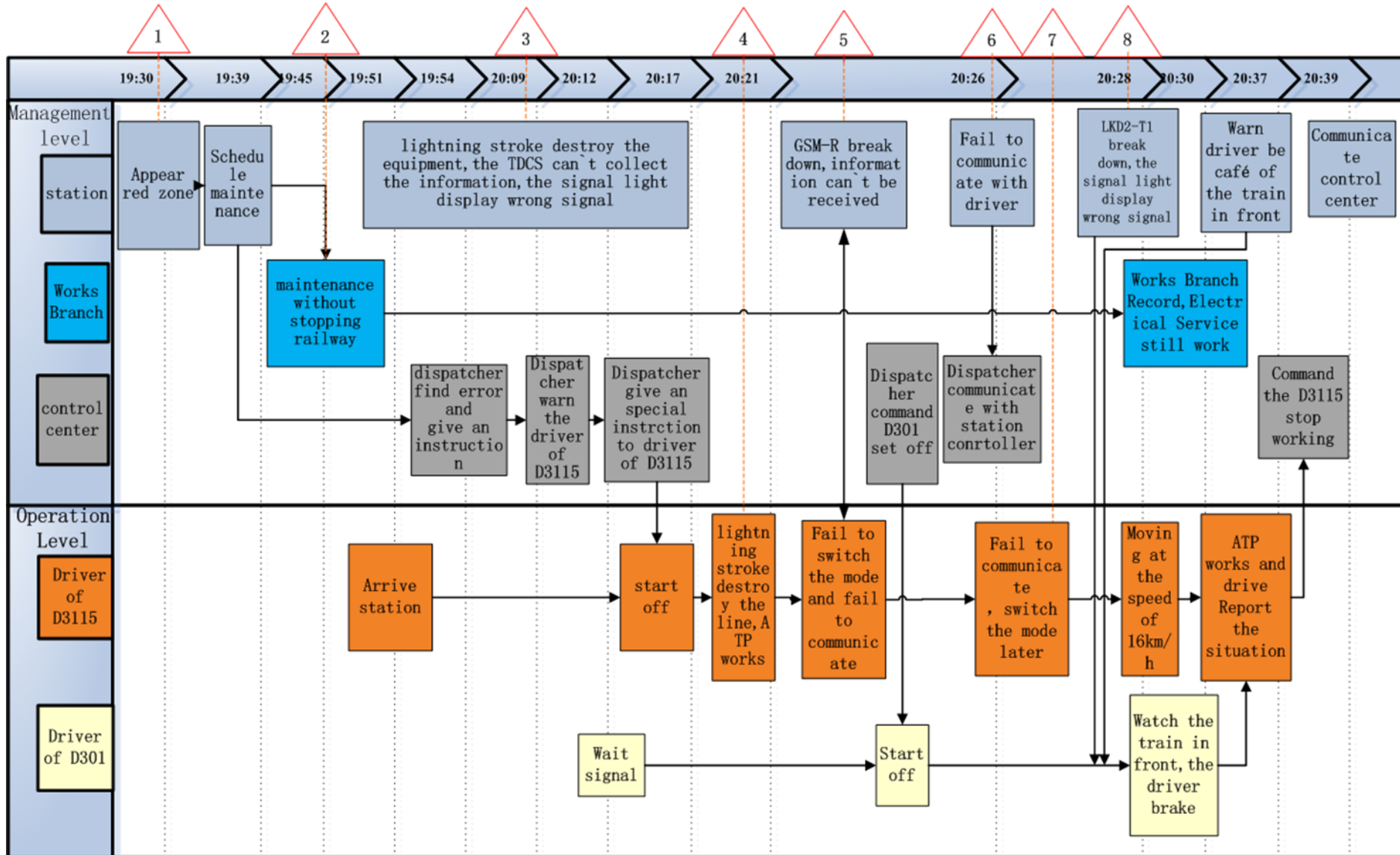


# Collecting data

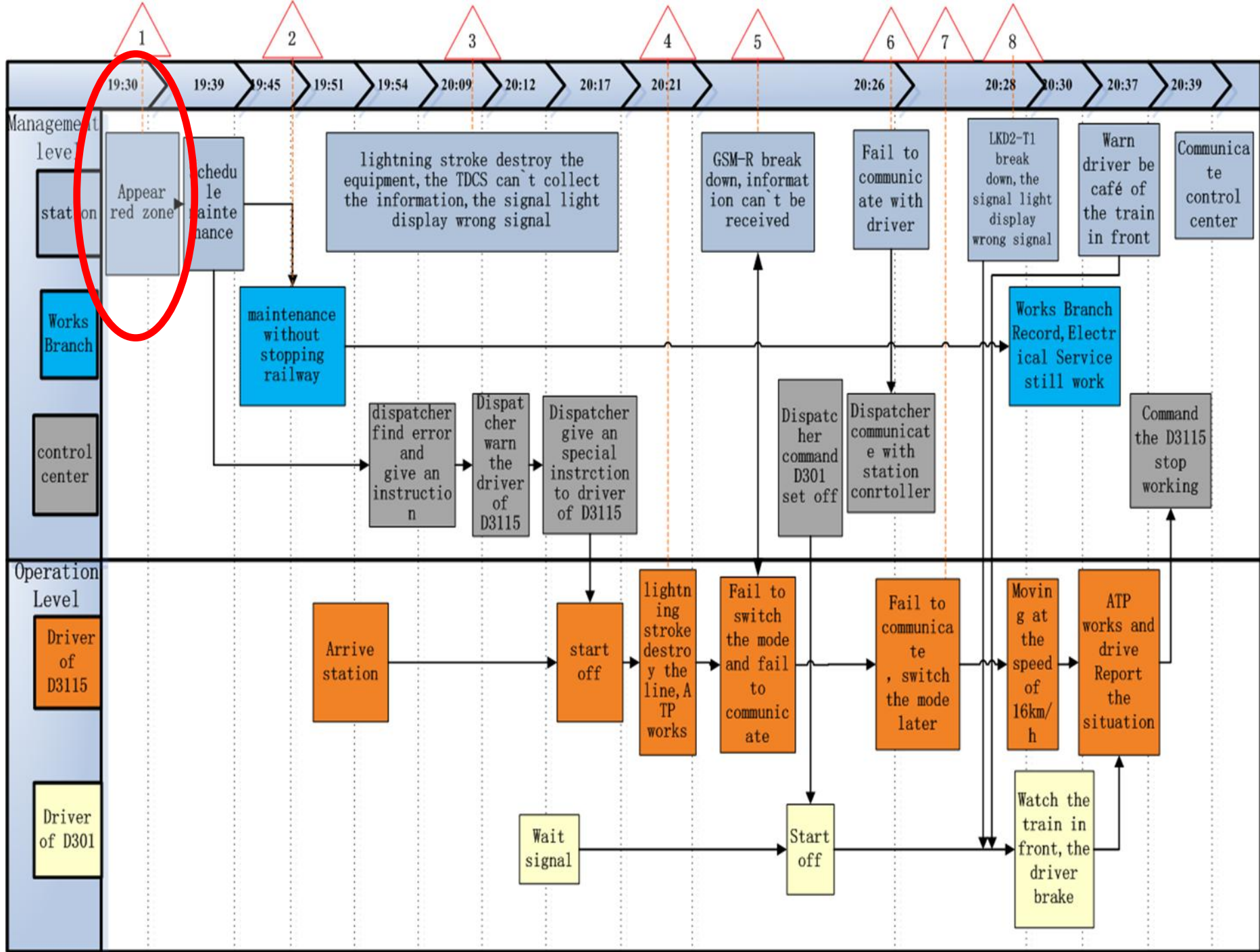
- China State Council: Investigation report of Yongwen railroad accident.
- Internet portal feature reports (Sina, Yahoo.cn)
- Railroad experts interviews in TV (CCTV, Phoenix Chinese Channel)
- [The process of the accident.docx](#)

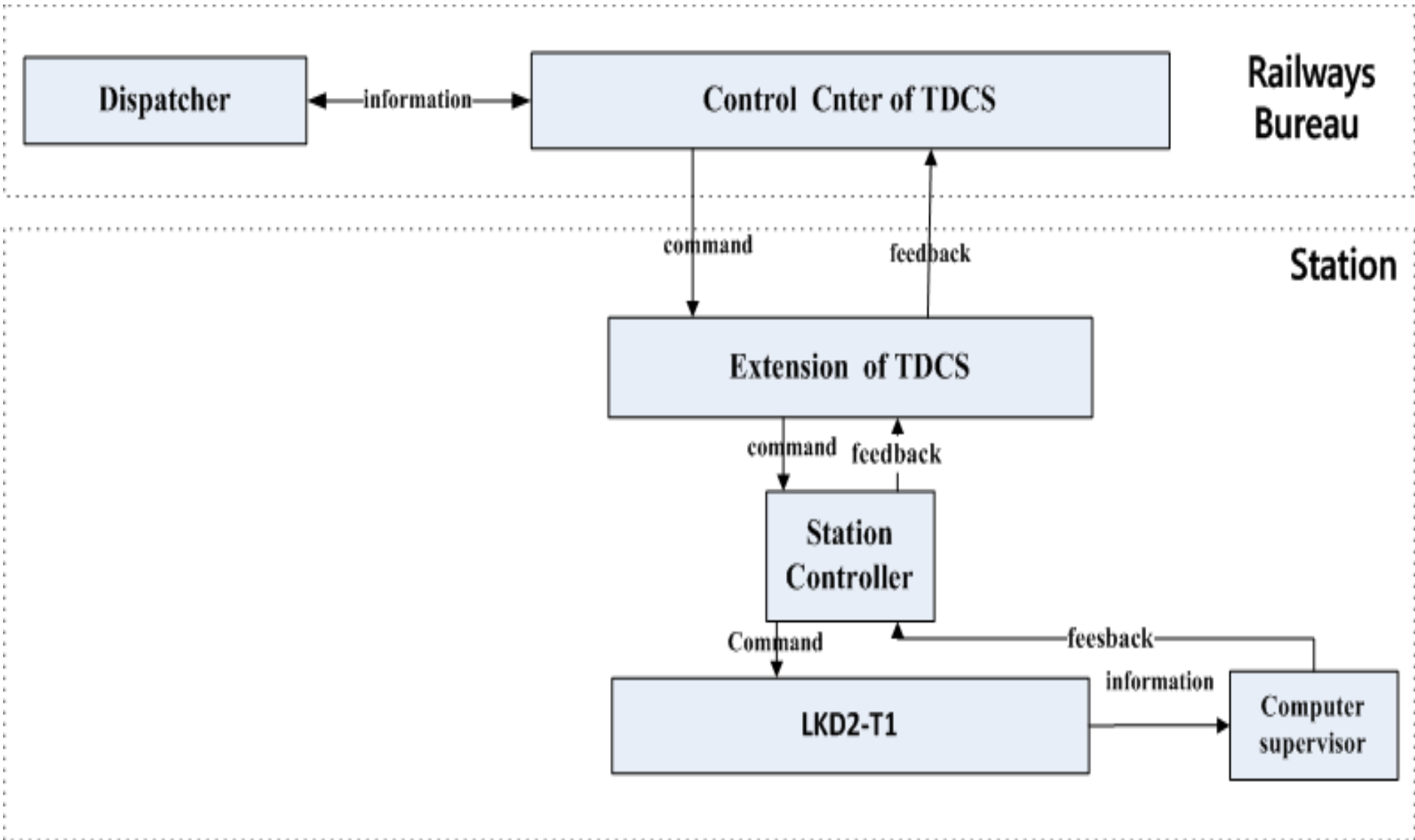


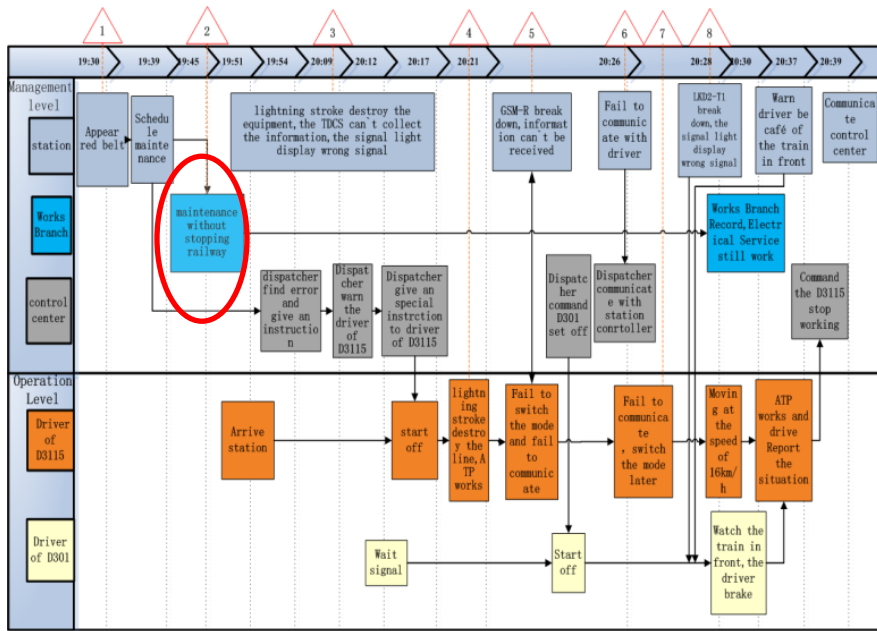
# Graph based on STEP



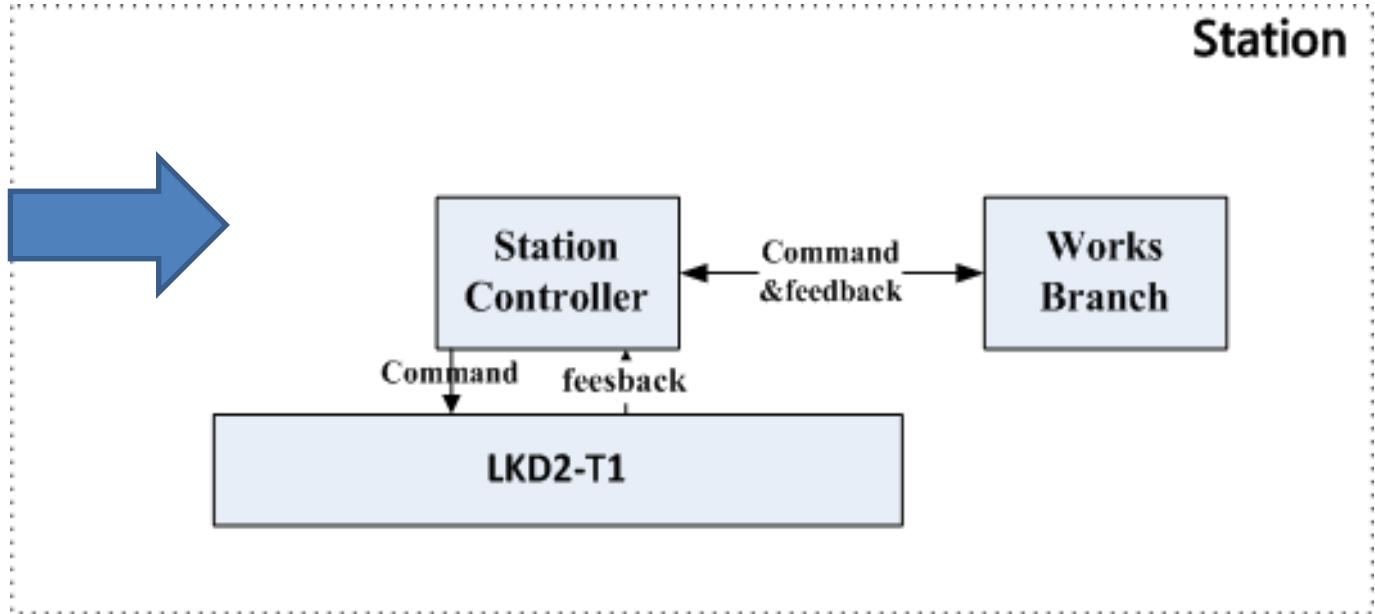
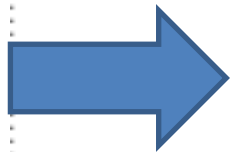


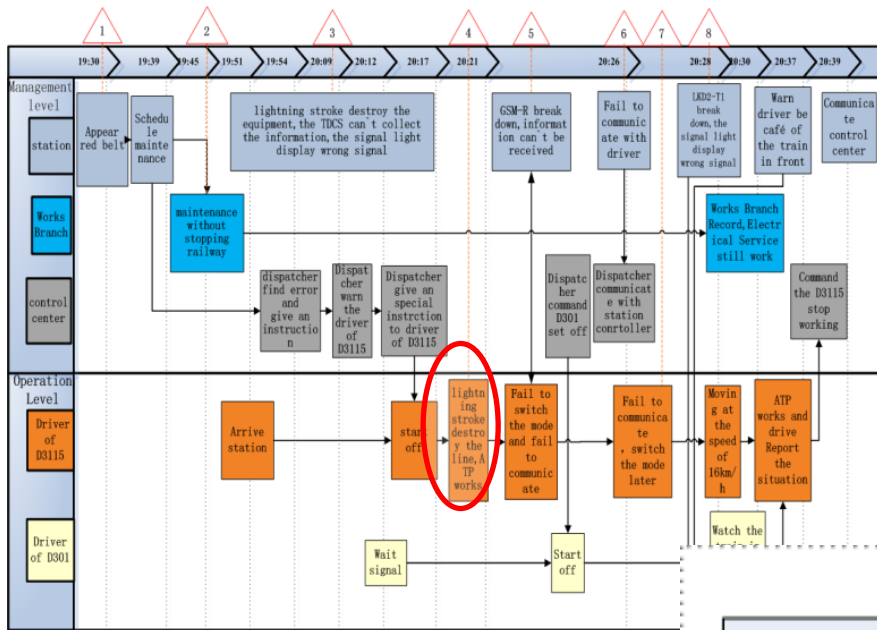




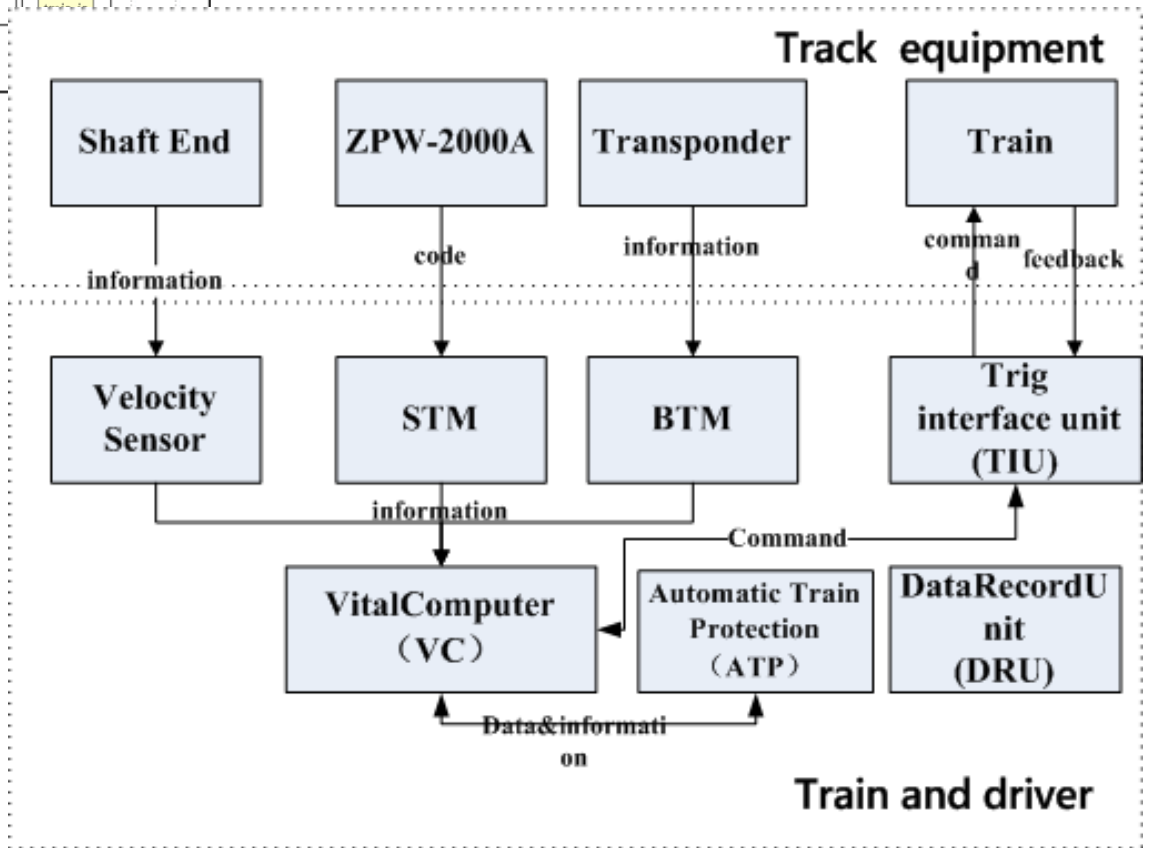
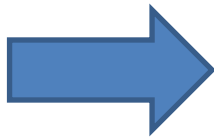


maintenance without stopping railway

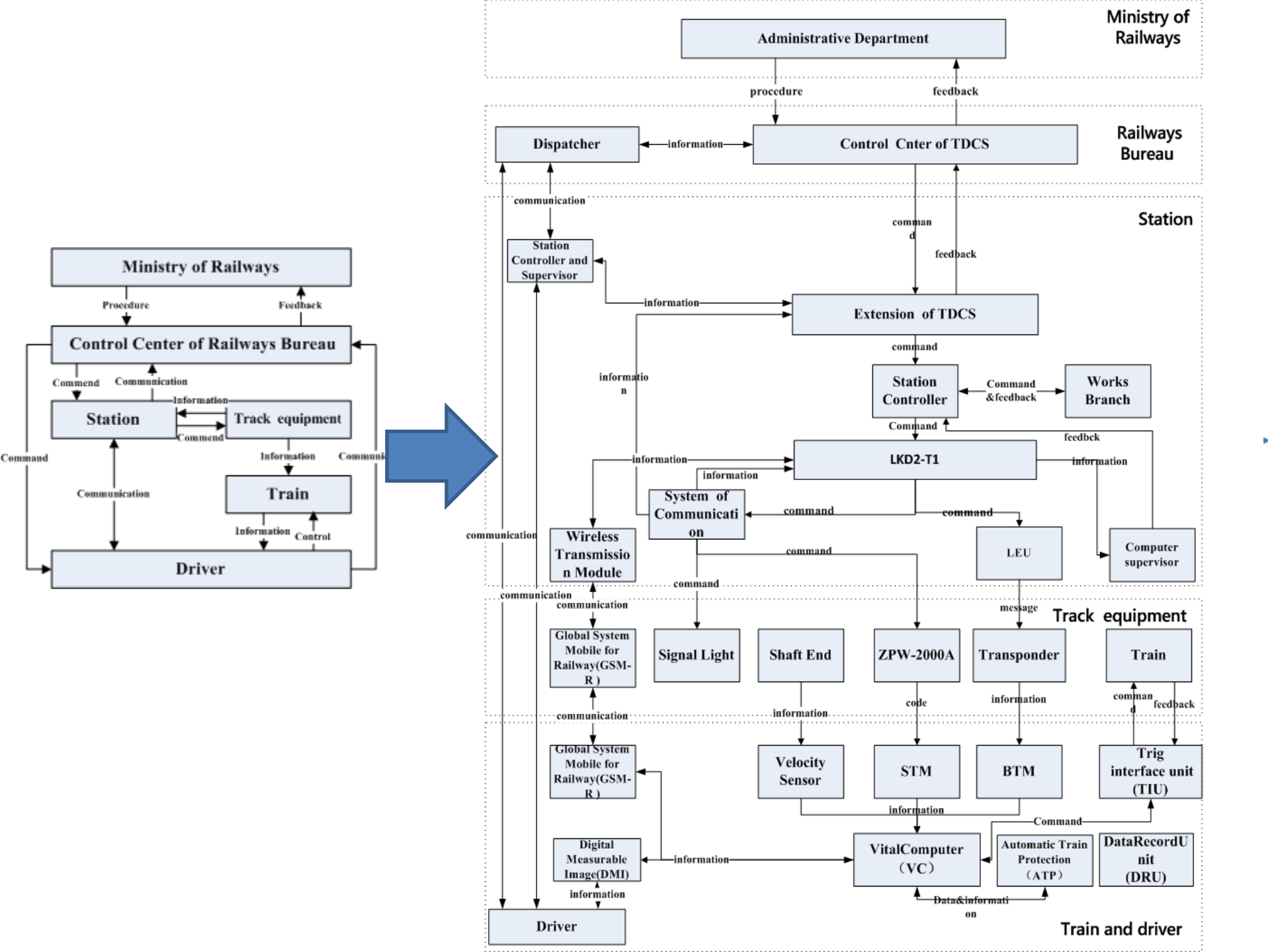


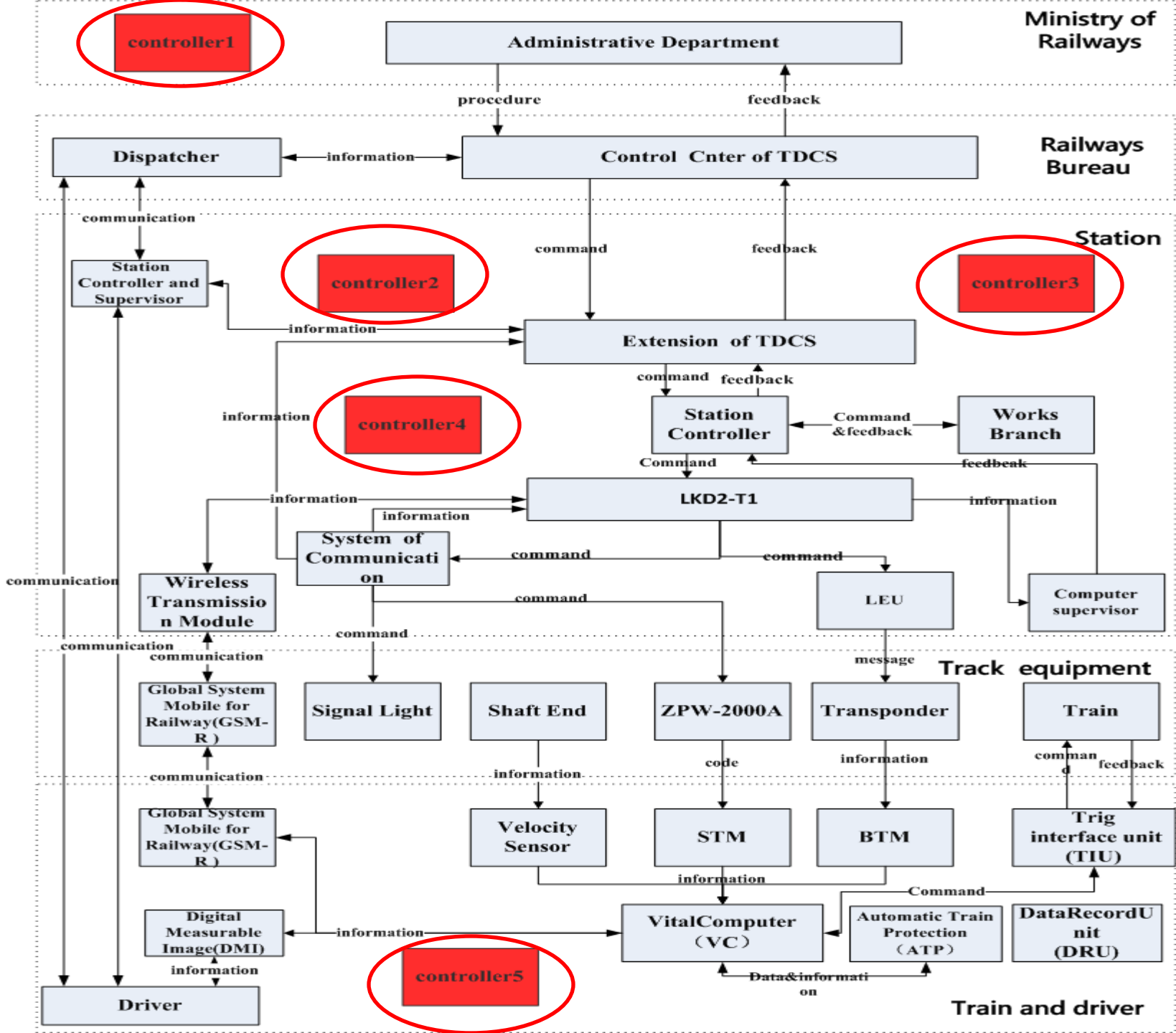


lightning stroke destroy the line, ATP works



Train and driver



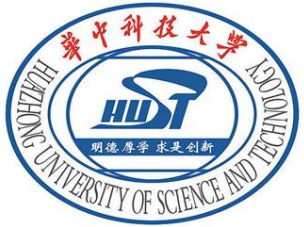




# Classification of the reasons

- **Human sources**
- **The rail (infrastructures)**
- **Power network (over power)**
- **Trains**
- **Electric signs**
- **Switch problems**
- **Electric equipment**
- **Passenger and cargo**
- **Natural disasters**
- **Third people**
- **Other factor**

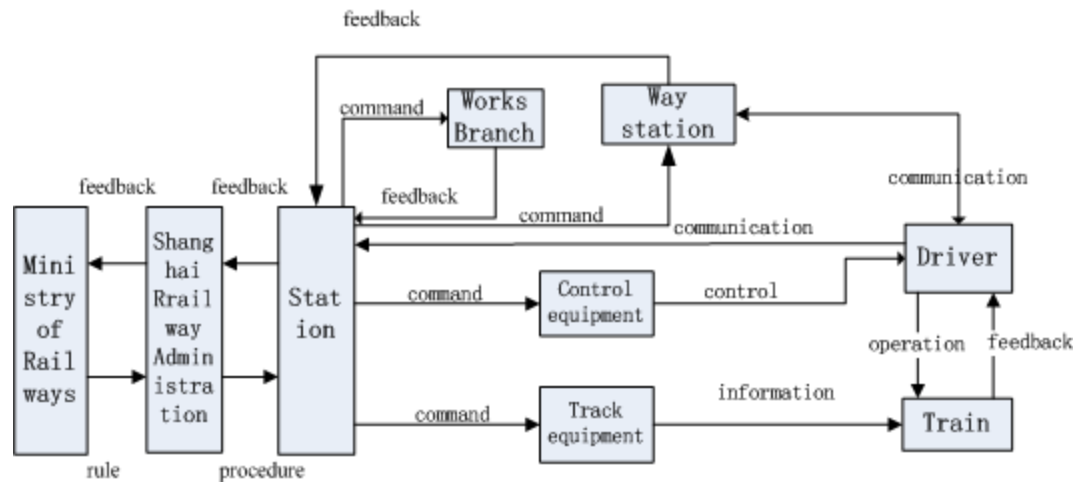
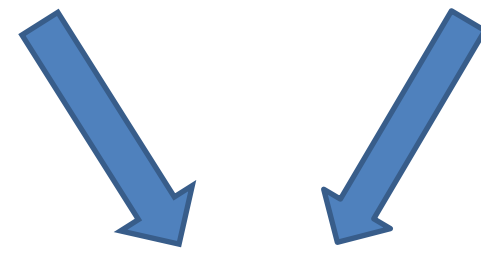
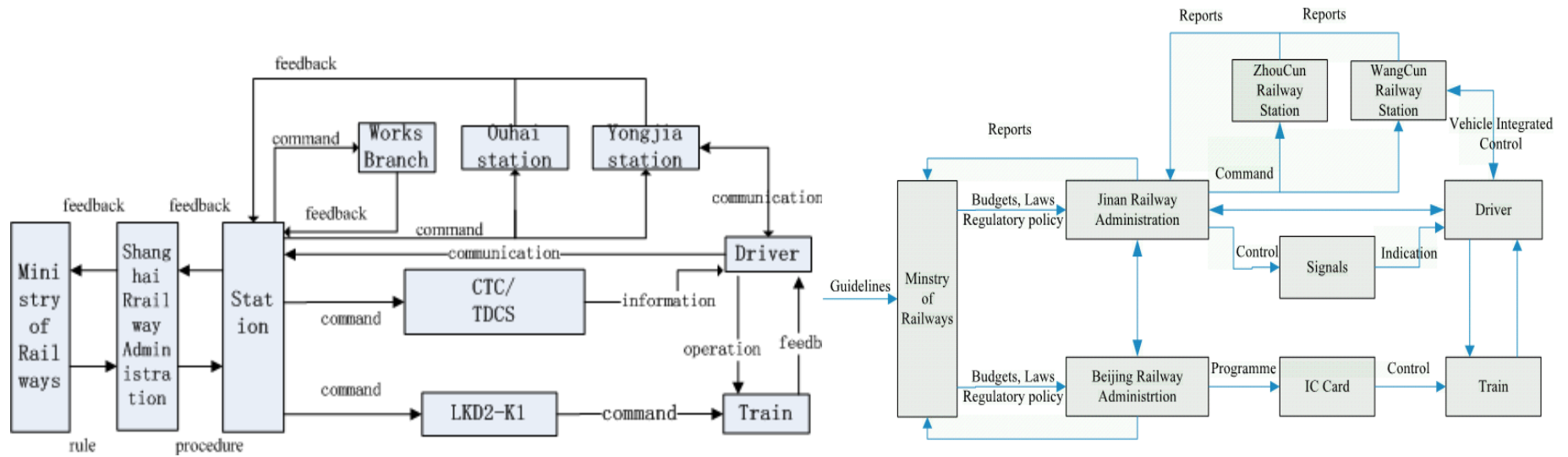
**UIC (International  
Union of Railway)**

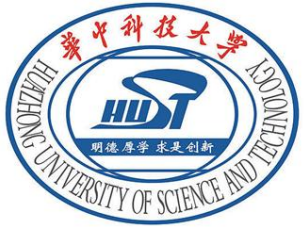


# Classification of the reasons

	Human sources	The rail (infrastructure)	Power network (over power)	Trains	Electric signs	Switch problems	Electric equipments	Passenger and cargo	Natural disasters	Third people	Other factor
MOR	①										② ③
Railways bureau	④ ⑤										⑥
Control center	⑦ ⑧ ⑨	⑩		⑪			⑫		⑬		
Station	⑭	⑮					⑯				
Track equipment				⑰	⑱				⑲		
Driver and train		⑳			㉑		㉒				







**THANK YOU!**



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