

# A System Theoretic Analysis of the "7.23" Yong-Tai-Wen Railway Accident

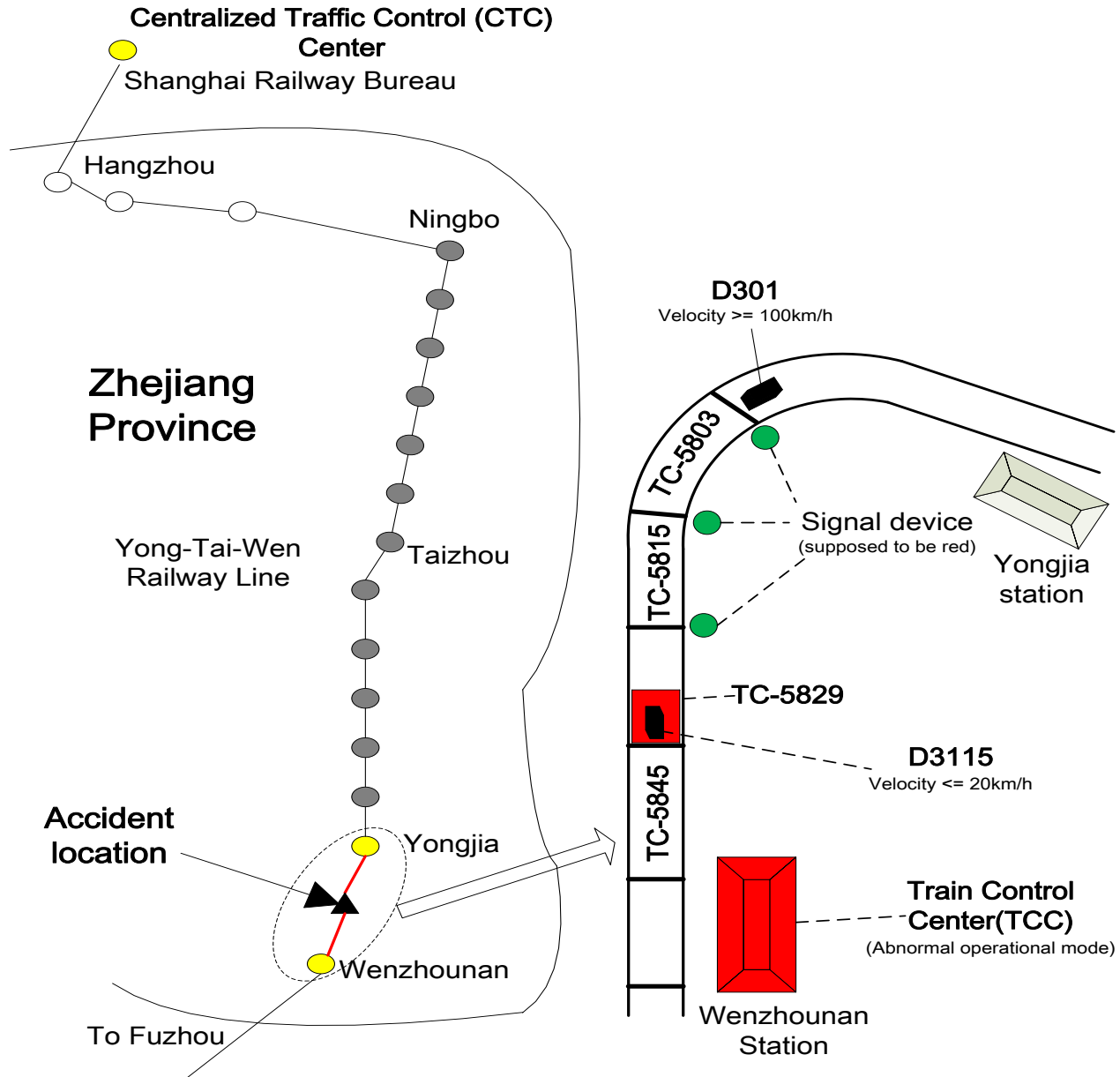


*1st STAMP/STPA Workshop*  
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*Tsinghua University*  
*2012-4*

# *Outline*

- ✧ **Background**
- ✧ **Chain of Events**
- ✧ **Safety control structure**
- ✧ **System dynamics of this accident**
- ✧ **Conclusion**

# Location of the accident



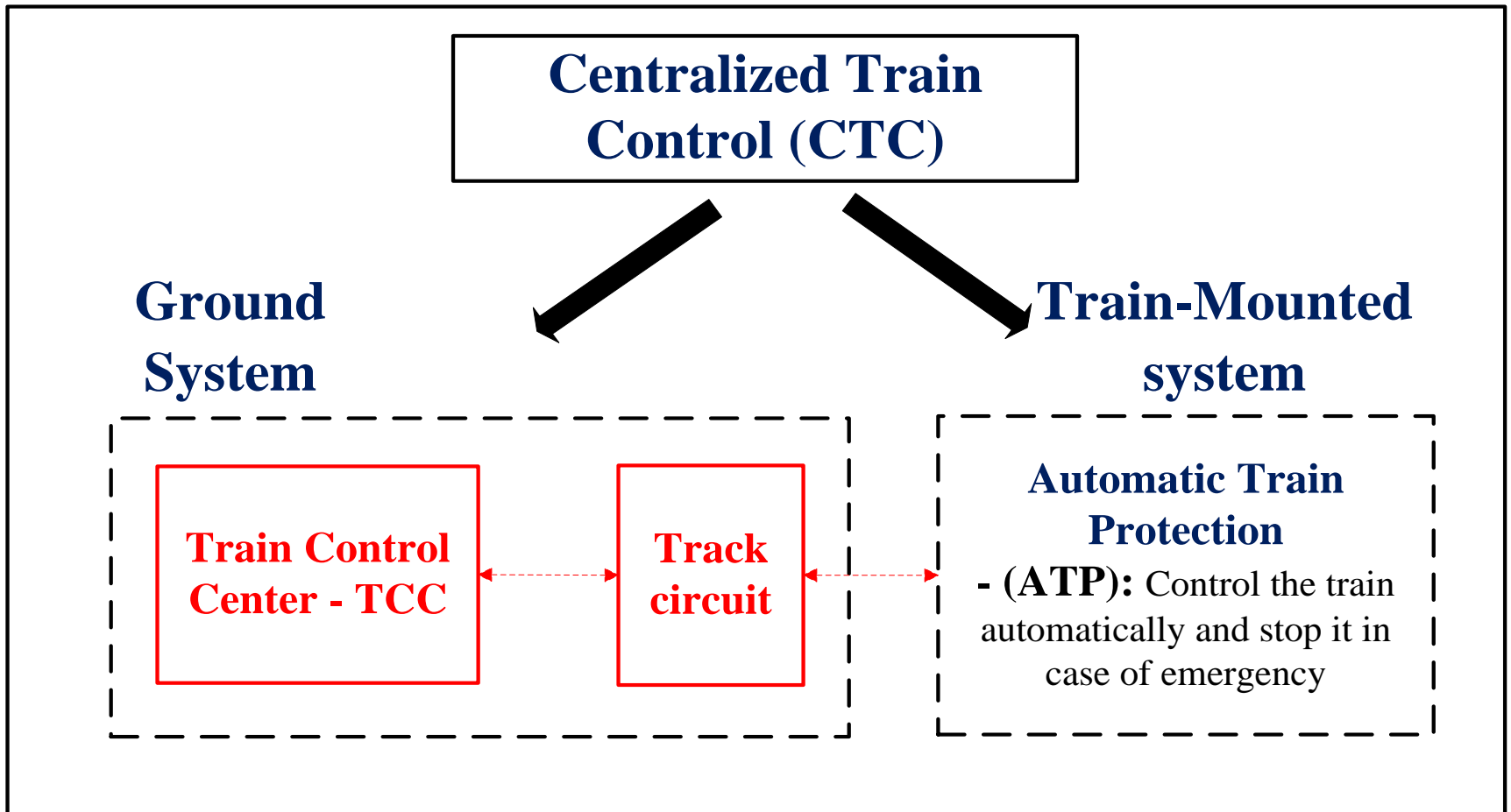
## *People involved*

- ✧ **Drivers (D3115&D301)**
- ✧ **Watch keep (Wenzhou Station)**
- ✧ **Electrical Workers**
- ✧ **Dispatcher (Shanghai Railway Bureau)**

# *Signal&Communication System*

## **Chinese Train Control System - Level 2**

(Designed for speed 200-250 km/h)



# *Important Definition*

“**Red Light Strip**” - represents the occupancy of the TC by the Train. Sometimes failures in the TC could lead to it;

“**Occlusive Section**” – Provide protection mechanisms which prevent two trains from travelling at different speed in the same “Occlusive Section”;

“**Decentralized autonomous control mode**”

“**Unconventional station control mode**”

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# *Chain of Events*



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# *Generic Components - Development*

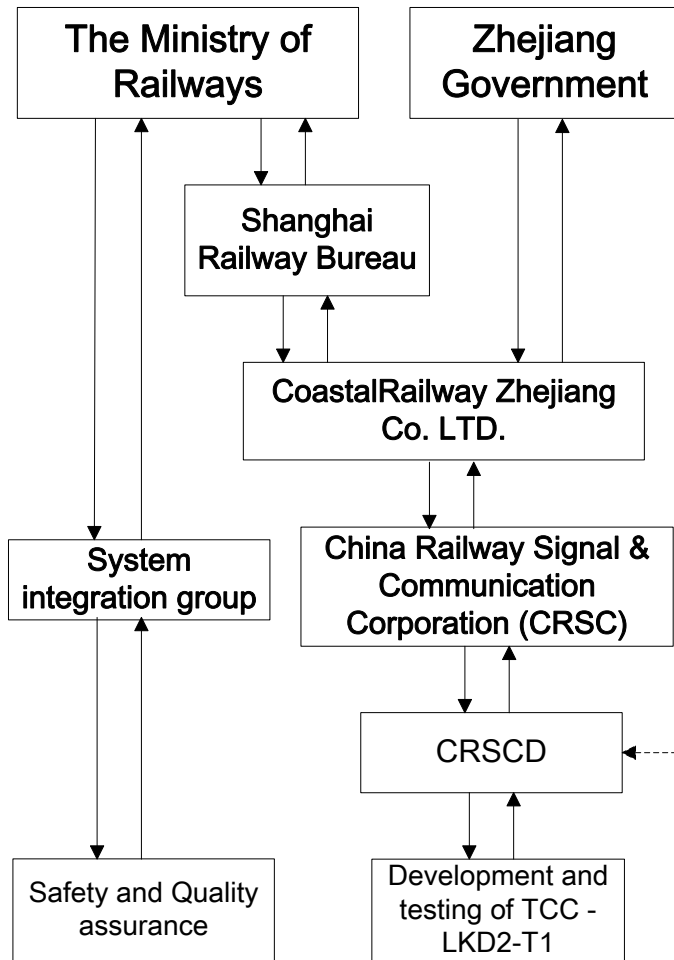
<b>Components in hierarchical safety control structure(Development)</b>	<b>The corresponding components in Chinese railway system</b>
<b>Governments regulation agencies</b>	Chinese Ministry of Railways
<b>Governments regulation agencies</b>	Zhejiang Government
<b>Maintenance and Evolution</b>	Shanghai Railway Bureau
<b>Company Management</b>	CoastalRailway Zhejiang Co. LTD
<b>Project Management</b>	China Railway Signal & Communication Corporation (CRSC)
<b>Design and Implementation</b>	Beijing National Railway Research&Design Institute of Signal&Comm Co. LTD
<b>Safety Assurance</b>	System Integration Group

# *Generic Components - Operation*

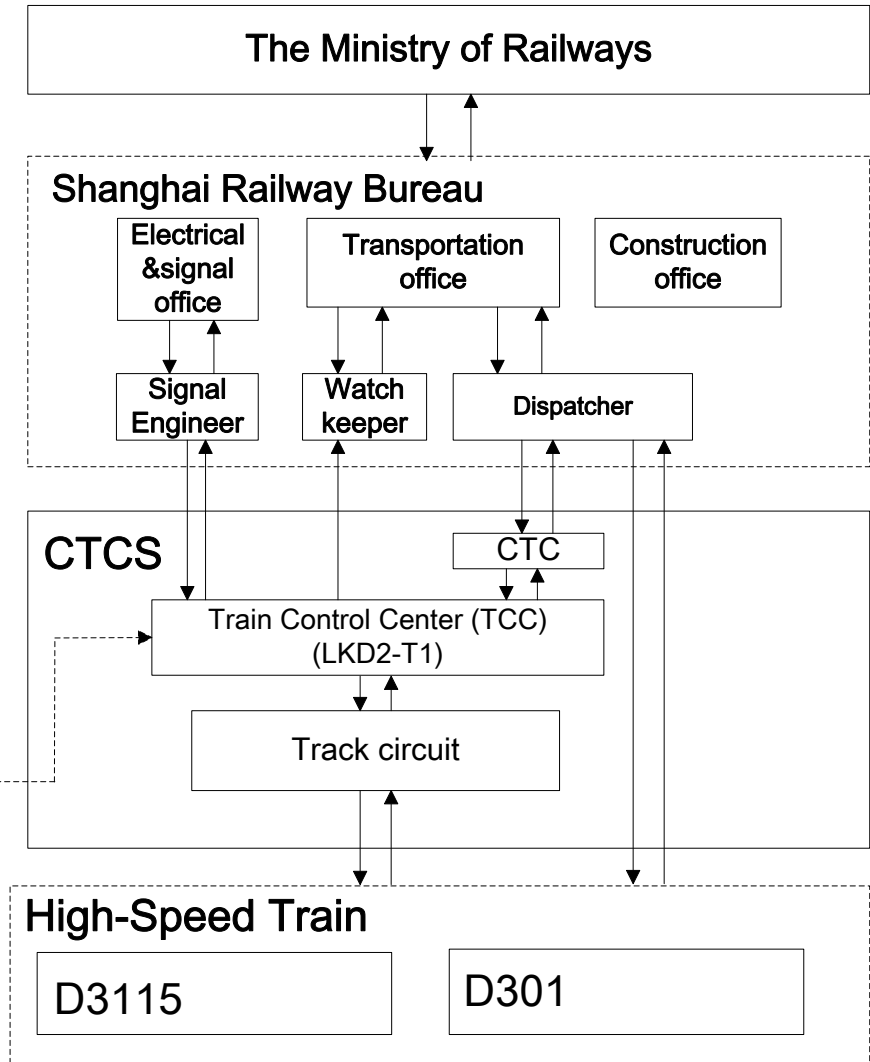
<b>Components in hierarchical safety control structure(Operation)</b>	<b>The corresponding components in Chinese railway system</b>
<b>Governments regulation agencies</b>	Chinese Ministry of Railways
<b>Safety Assurance and Supervision</b>	Shanghai Railway Bureau
<b>Maintenance</b>	Electrical&Signal Office
<b>Operation</b>	Transportation Office
<b>Operation &amp; Maintenance</b>	Wenzhou Station

# Safety Control Structure

## System Development



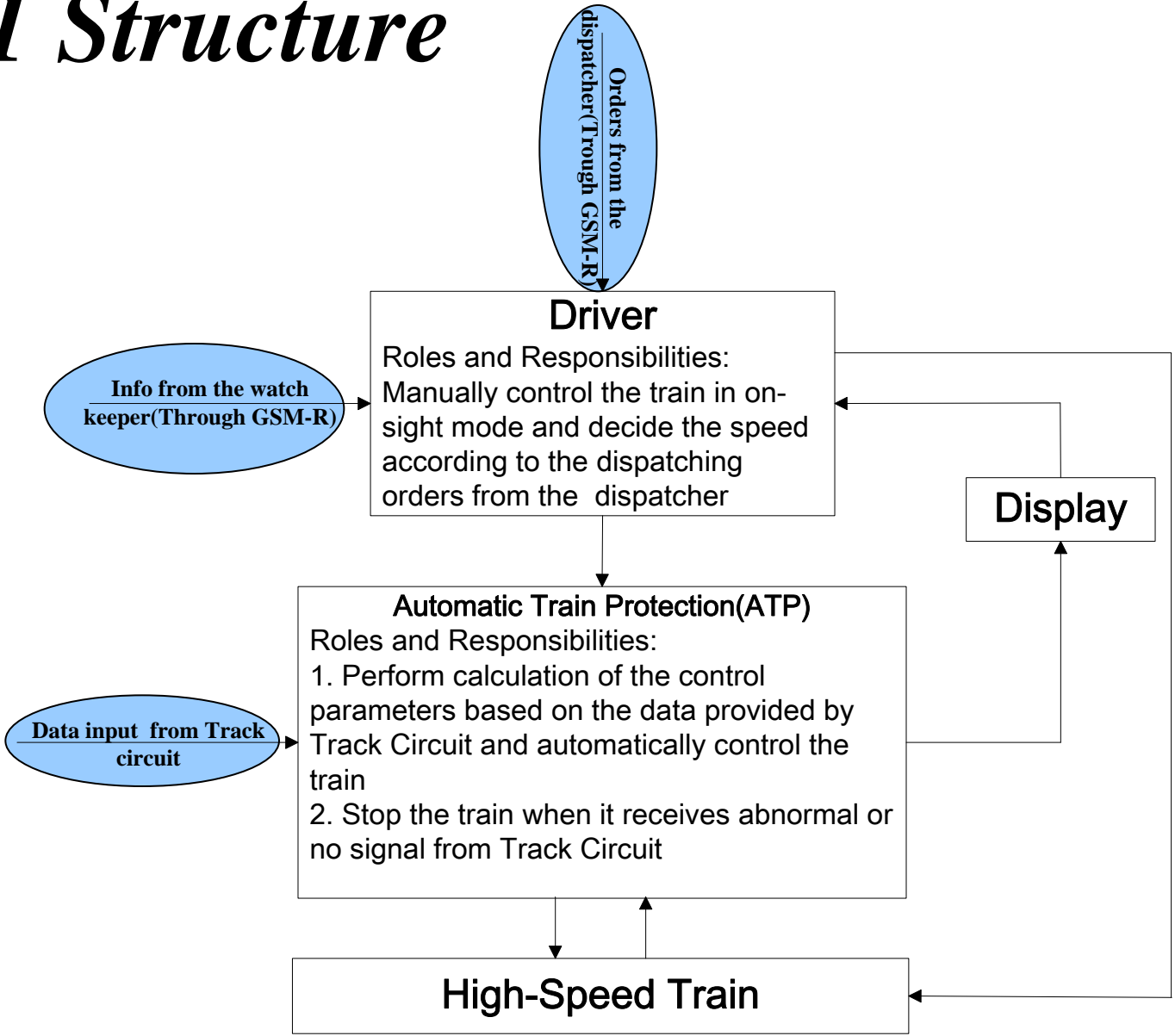
## System Operation



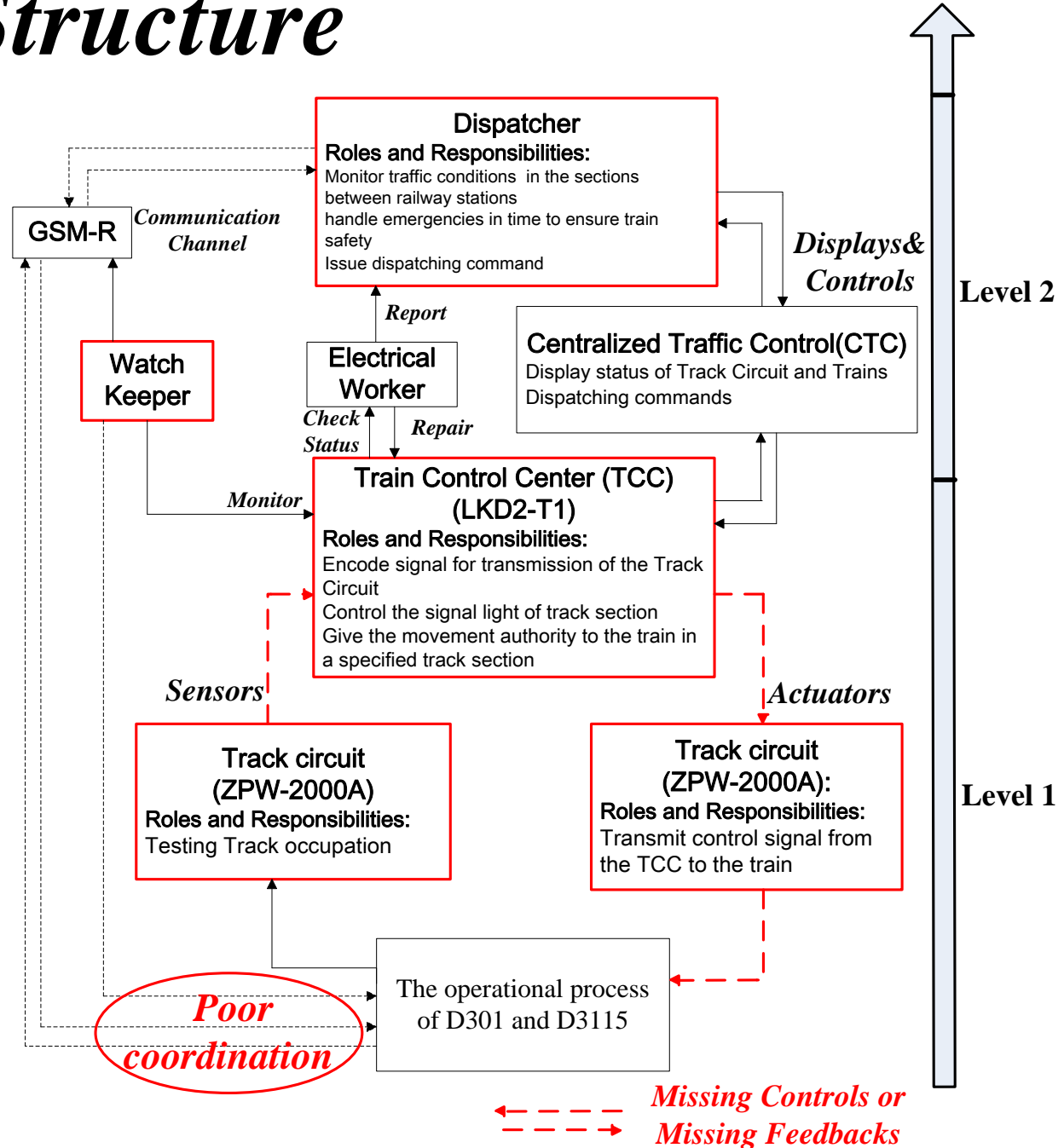
# *System Hazard and safety constraints*

- **System Hazard:** Two trains are on the same “Occlusive Section” travelling at different speed
- **Safety Constraints:**
  - (1) When a track section is occupied by a train, the TCC transmits control parameters representing track occupancy to other trains and issues warning signals (red) to the signal device in front of this section.
  - (2) The failures in the Train Control System must be identified and provided as feedback to the dispatcher of CTC in time.
  - (3) The dispatcher in the CTC and the watch keeper should identify the potential danger in the railway line and command the train to slow down or stop in emergency situations.

# Level 1 Structure

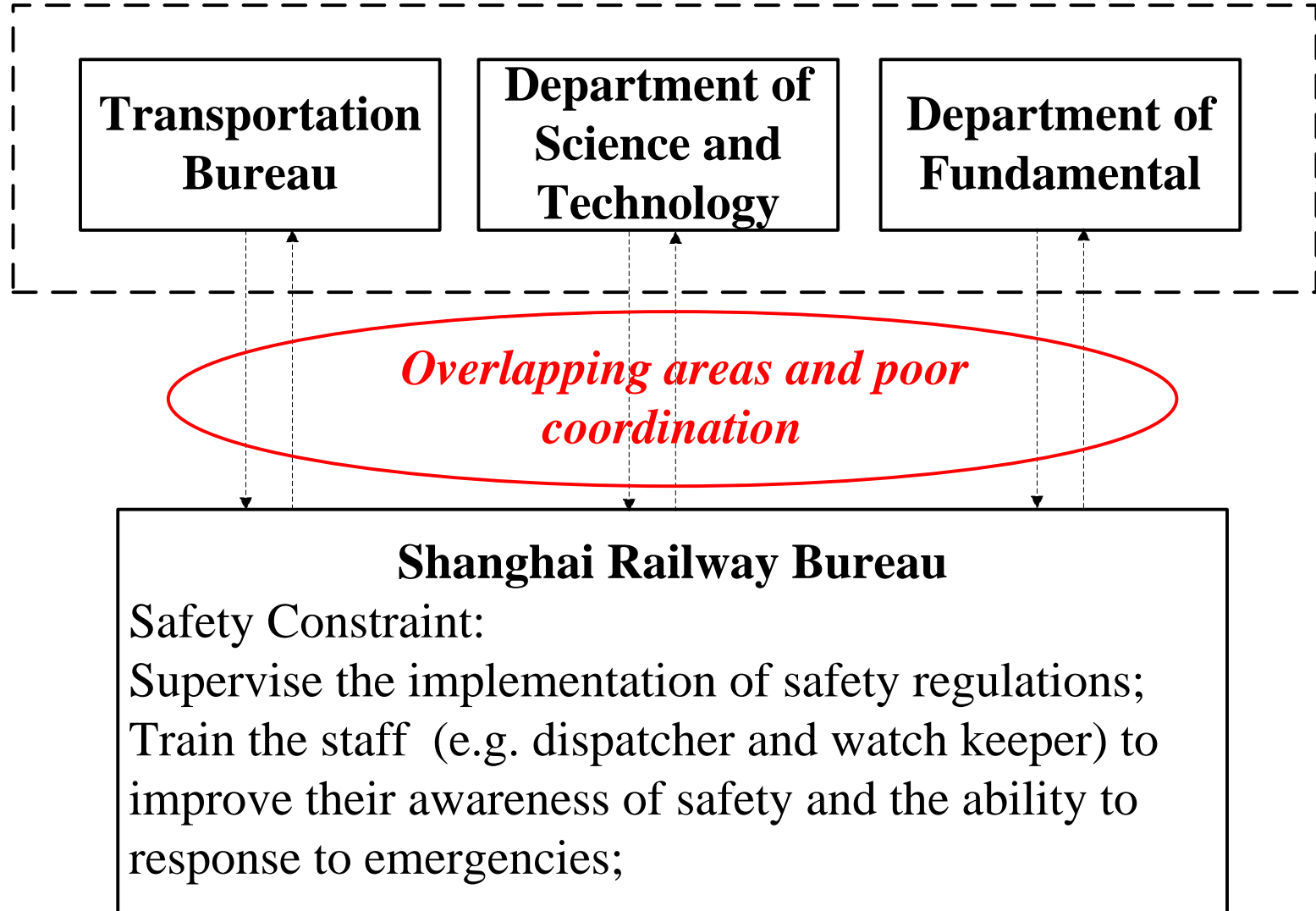


# Level 2 Structure



# *Level 3 Structure*

## **The Minister of Railways**

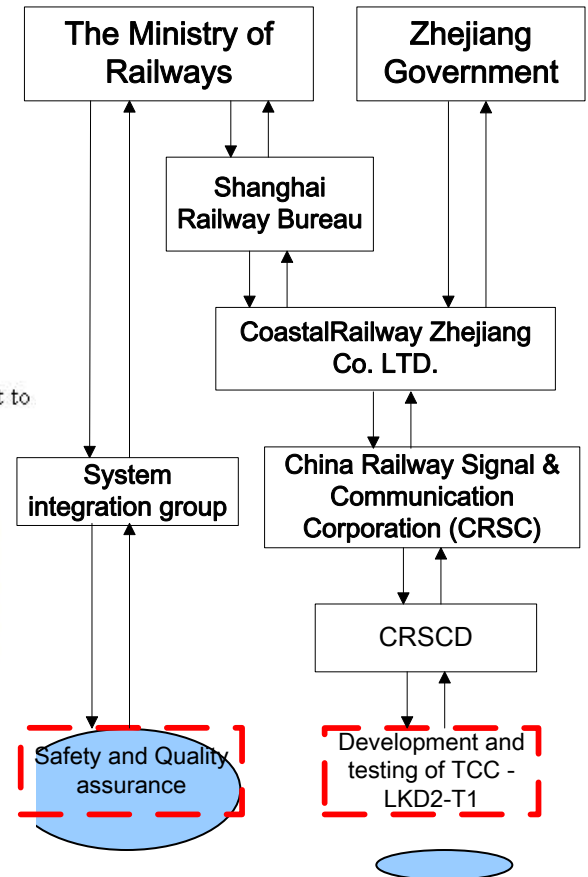
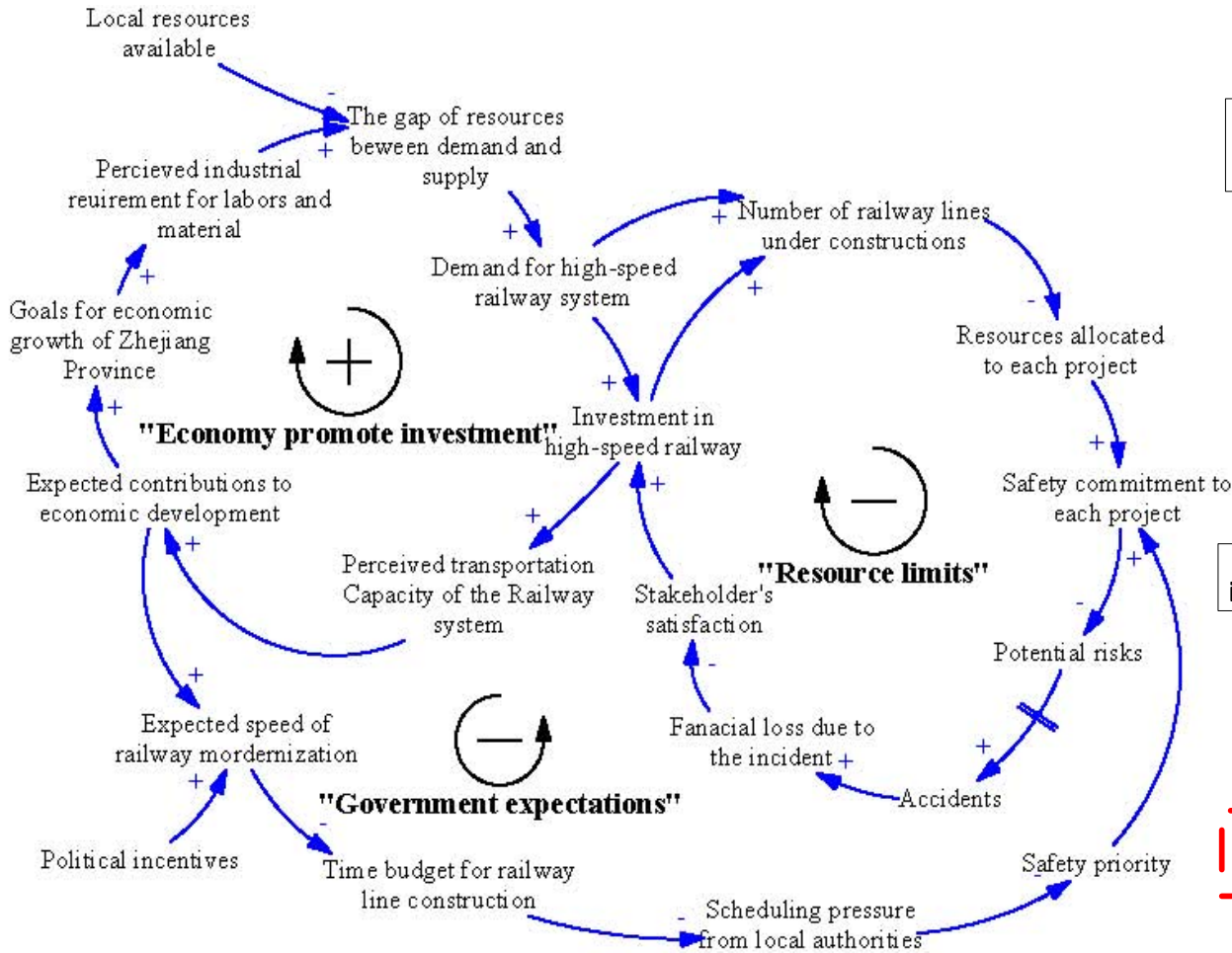




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# System development

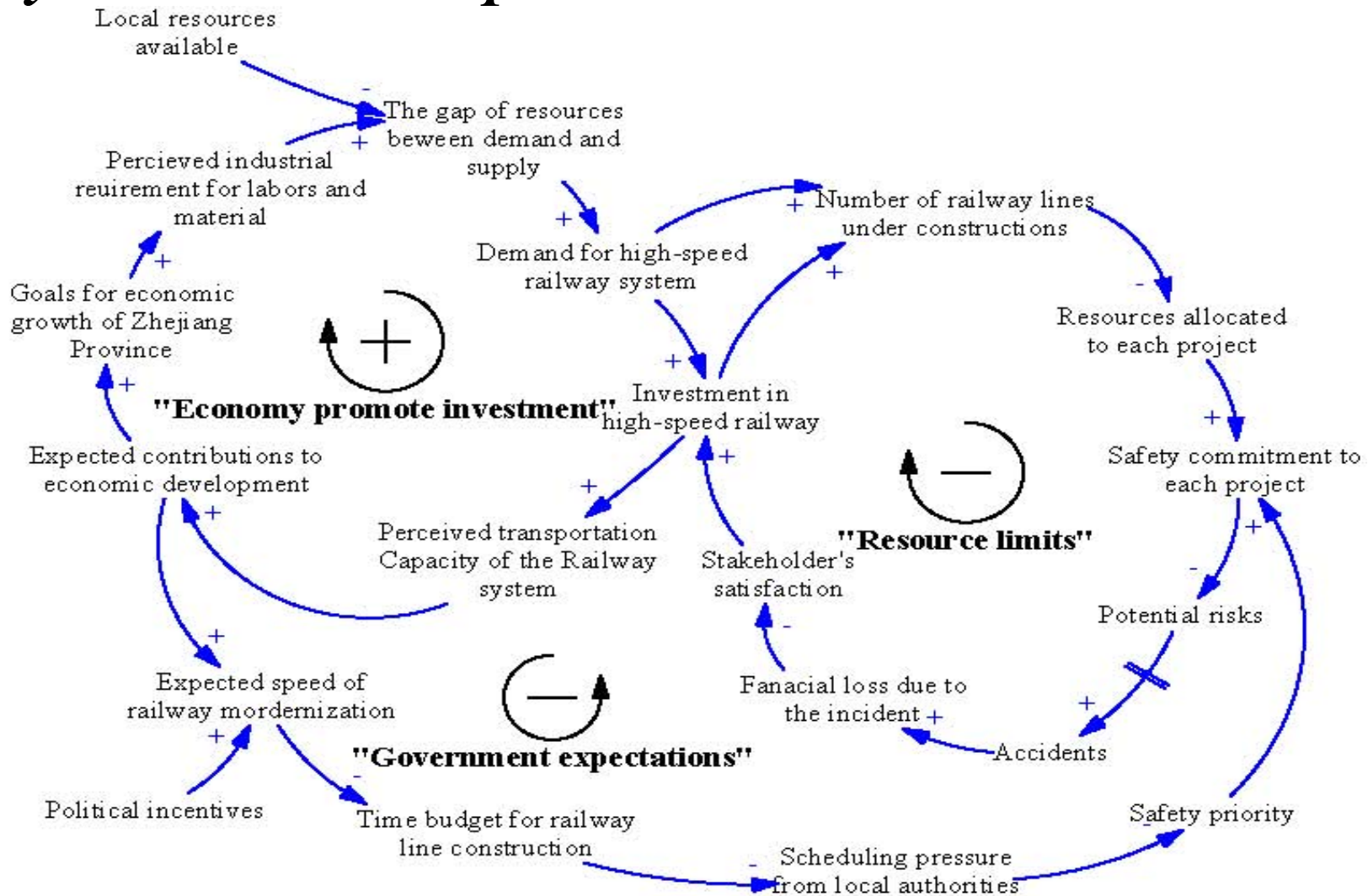


◆ Incentives to economic development – Easy access to labors and raw material

# *Plan for the high-speed Railways within Zhejiang Province in 2010*

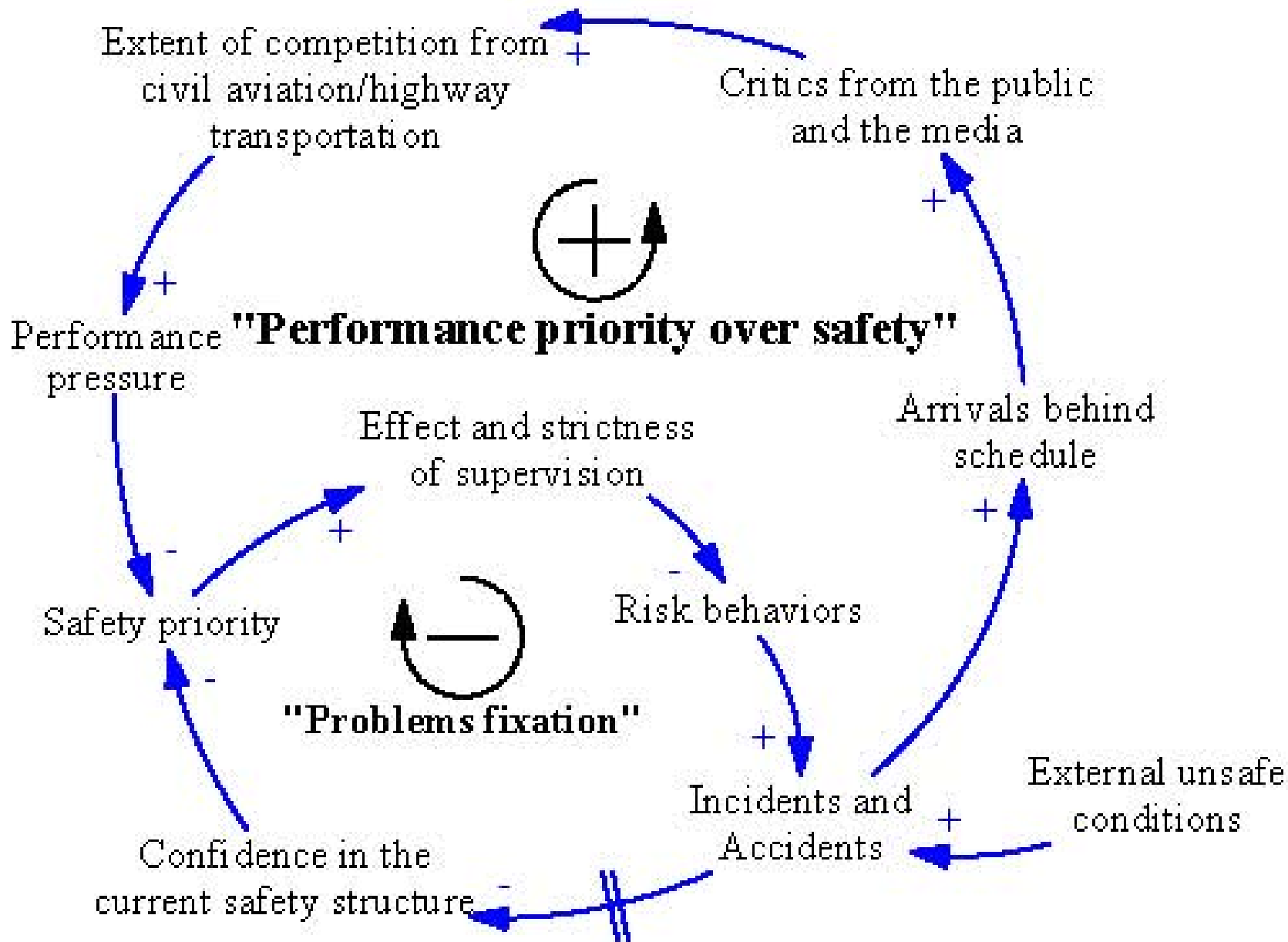
<i><b>Railway lines</b></i>	<i><b>Start</b></i>	<i><b>Finish</b></i>
Yong-Tai-Wen		Finished
Shanghai-Hangzhou		Finished
Hangzhou-Ningbo	2008.12	2011
Hangzhou-Nanjing	2008.12	2011
Hangzhou-Changsha	2009	2013
Hangzhou-Huangshan		
Shangqiu-Hangzhou	Plan-2011	
Nantong-Jiaxing		
Huzhou-Shanghai	Plan-2012	

# System development



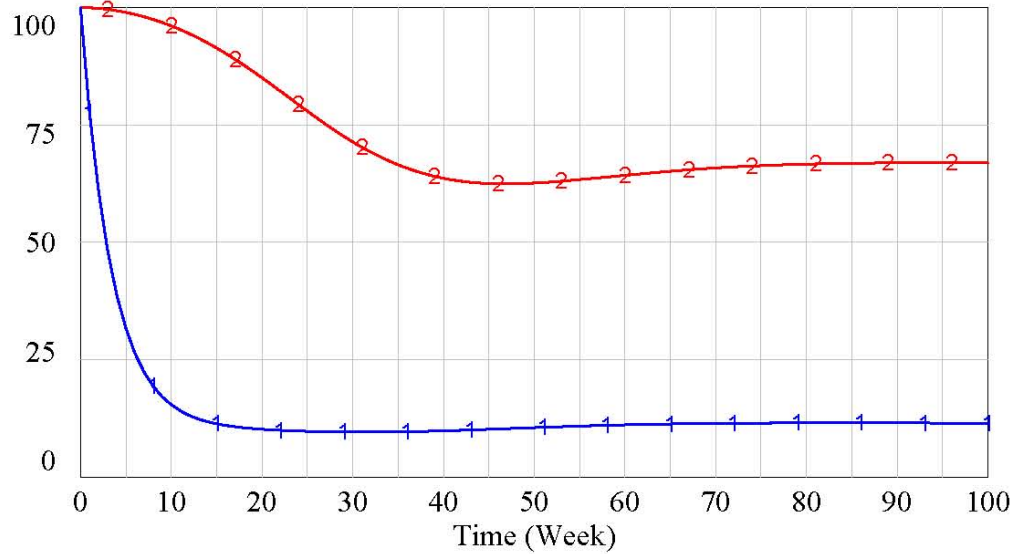
◆ Goal – The first province in China to realize modernization of high-speed Railways

# System Operation

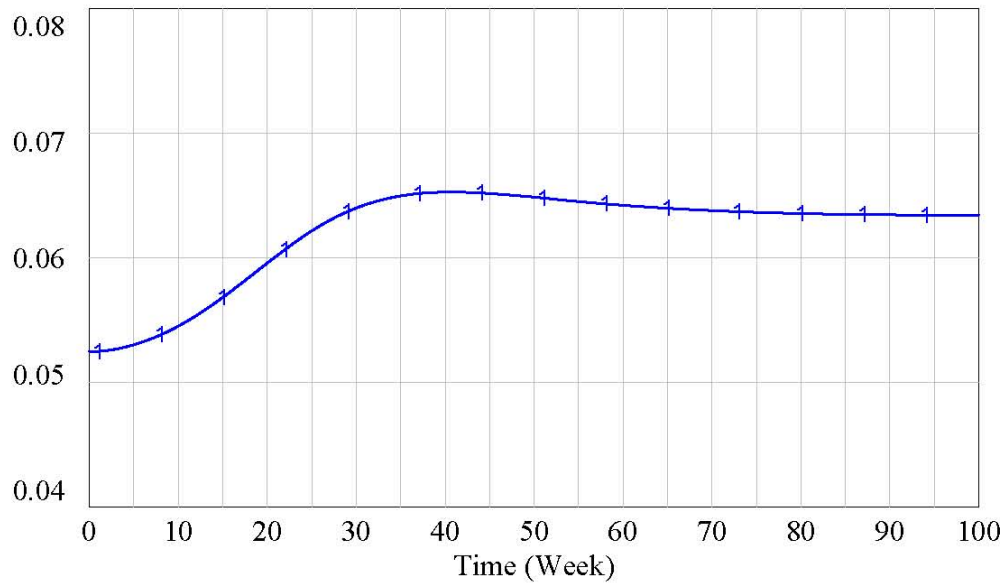




# Simulation results



Safety priority : Current — 1 1 1 1 1 1 1 1 1 1 1  
System safety : Current — 2 2 2 2 2 2 2 2 2 2 2



Incidents and Accidents rate : Current — 1 1 1 1 1 1 1 1 1 1 1

## *Conclusion - See the “7.23” accident from a system perspective based on STAMP*

- ✧ Safety regulations must be established to ensure the enforcement of safety constraints
- ✧ Channels for transmitting feedback should be kept open
- ✧ Human and organizational factors play a critical role in the accidents
- ✧ Safety commitment must be made during the whole process of the system development and operation





**Thanks!**

**Q&A**

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