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IRSC 2025

Advancing Railway Safety through Innovations and Collaborations

Hong Kong, China 25th - 30th November 2025

功能安全之上 — 運營韌性時代的全域安全範式

Beyond Functional Safety, A Holistic Safety Paradigm for the Era of Operational Resilience

汪小勇 博士

Dr. Xiaoyong WANG

副总裁，卡斯柯信號有限公司

VP, CASCO Signal Ltd.

運營韌性時代的到來
The Era of Operational Resilience is coming…

超強客流
Super-intensive ridership

超大網路
Super-complex networks

截至 2024 年 12 月，上海地鐵
As of December 2024, Shanghai Metro: 資料來源於網路搜索
運營線路共 *21* 條 Operates *21* lines in total
運營里程 *896* 公里 *896* kilometers operational mileage
共設*517* 座運營車站，*517* operating stations
高峰同時線上運營車輛*1000*輛
1,000 RS operate simultaneously during peak hours

超新技術
super-advanced technologies

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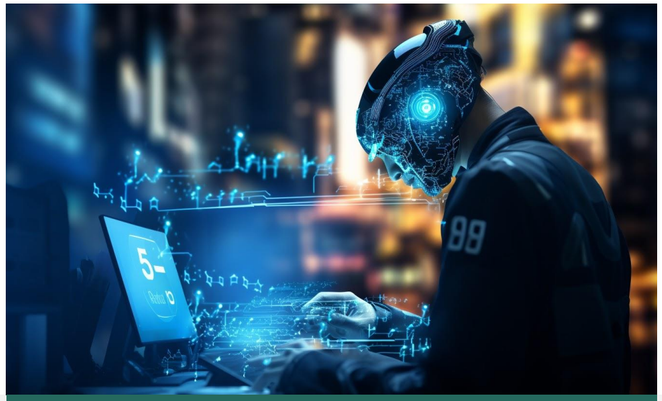
僅考慮功能安全，難以完全滿足運營韌性時代的需求
Functional safety is not enough in the Era of Operational Resilience

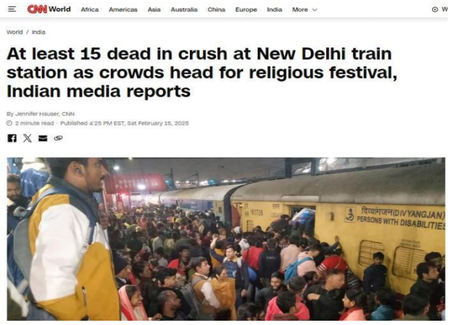
系統性故障級聯反應
Systemic Cascading Failures

非技術威脅
Non-Technical Threats



人 - 系統複雜性
Human-System Complexity

僅考慮功能安全，難以完全滿足運營韌性時代的需求
Functional safety is not enough in the Era of Operational Resilience


CNN World Africa Americas Asia Australia China Europe India More

World / India

At least 15 dead in crush at New Delhi train station as crowds head for religious festival, Indian media reports

By Jennifer Hauser, CNN

2 minute read · Published 4:25 PM EST, Sat February 15, 2025

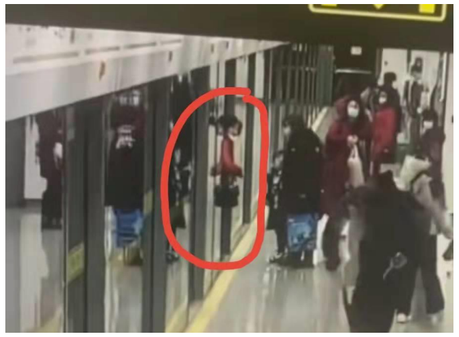
中國新聞

對低溫雨雪冰凍災害防範應對工作作出重要指示

習近平：全力做好突發險情應對處置　確保人民群眾安全溫暖過冬

北京地鐵雪天軌滑致兩列車追尾　102人骨折

515人送醫檢查　無人員死亡　北京市政府成立事故調查組將嚴肅追責



印度新德里車站踩踏事件
Stampede Incident at New Delhi Station, India

北京昌平線追尾事故
the Collision on Beijing's Changping Line

莫斯科地鐵app及網站遭網路攻擊突發大規模服務中斷
Moscow subway app and website disrupted in possible retaliation for Ukraine railway hack

上海15號線遮罩門夾人事故
PSD pinching Accident on Shanghai Metro Line 15

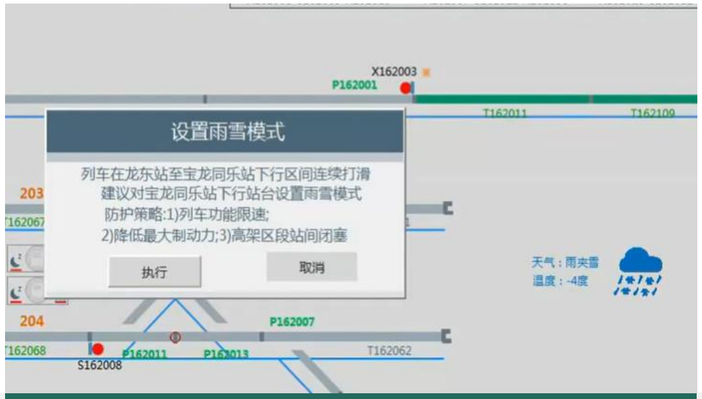
全域安全, 運營韌性的要求
Holistic Safety, Mandatory for operational resilience

主題 Theme	功能安全 FS (Functional Safety)	全域安全 HS (Holistic Safety)
安全概念 **Safety concept**	無事故和無事件；Absence of accidents and incidents 免於不可接受的風險Freedom from unacceptable risks	在不同環境下達成目標的能力 The ability to succeed under varying conditions
安全目標 **Safety goal**	避免事故發生 Avoid the occurrence of accidents	維持運營韌性(適應-調整-恢復) Maintain operational resilience(Adaptation - Adjustment - Recovery)
關注焦點 **Focus**	子系統組件 Subsystem/ component	複雜系統整體 Complex system as a whole
應對方式 **Response methods**	被動防護 Passive protection	主動適應 Proactive adaptation
文化導向 **Cultural Orientation**	合規驅動、反應式 Compliance-driven, reactive	運營導向、學習式 Operation-oriented, learning-based

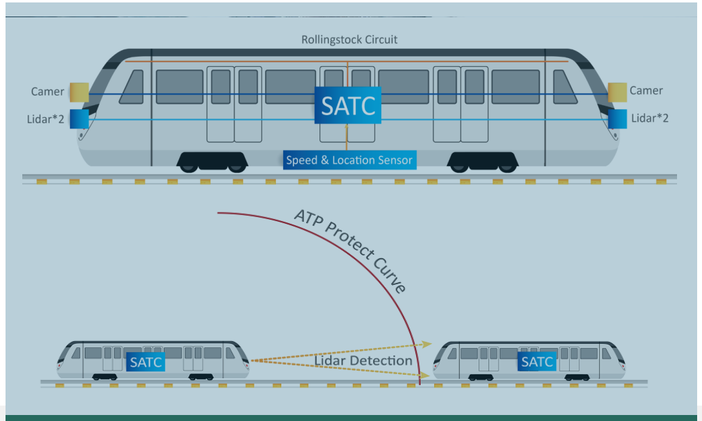
全域安全範式框架
Framework of HSP(**H**olistic **S**afety **P**aradigm)

全域安全範式的技術實踐
Technical Practice of the HSP

前攝性
Predictability

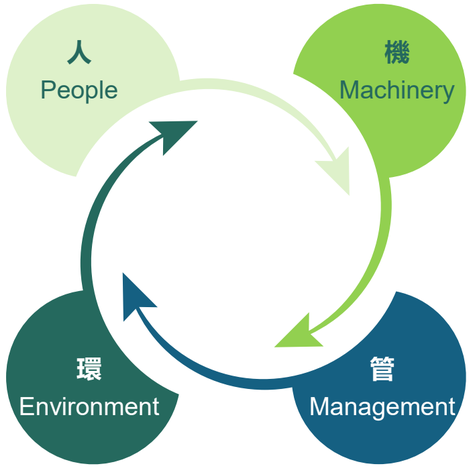


適應性
Adaptability



魯棒性
Robustness

全域安全範式的人文與文化實踐
Human & Cultural Practice of HSP



全災種
All-Hazards

全過程
Whole-Process

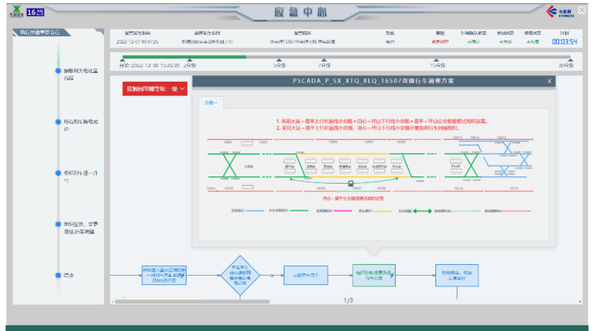
全要素
All-Elements

全域安全範式的組織流程實踐
Organizational & Process Practice of HSP

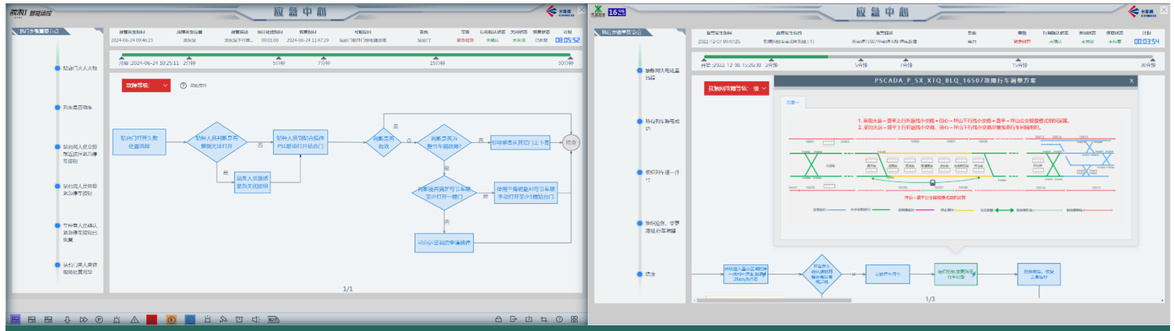
組織流程保障，從“限制人”到“賦能人”到“解放人”

Organizational Process Assurance: From “constraint" to “power & self-innovate”

綜合管控Integrated Monitoring



應急協同Fault-Coordination



輔助決策Decision Support

多維運營安全防護提升

Multi-dimensional improvement of operational safety

主動安全防護
Multiple active protections

運營處置效率
Operational efficiency

故障恢復時間
Fault recovery time

全域安全範式的資訊實踐
Informational Practice of HSP

網路安全：信號系統數位化的又一基石 Cybersecurity: the basis during digitalization of signaling system

雙安融合Integraration Of Safety and security

功能安全 functional safety	網路安全 Cybersecurity

解決方案Solution

- 基於國內外法規標準Based on china/oversea standards

產品 Product

- 建設業務融合的私人網路絡安全產品
  Specific cybersecurity product for signaling system

服務 Service

- 面向業務網安全生命週期服務Whole Lifecycle service

SGS

VERIFICATION OF COMPLIANCE

No.:	CYBR GZES2204006533PF
Applicant:	CASCO SIGNAL LTD
Manufacturer:	CASCO SIGNAL LTD
Product Name:	10th of Ramadan Railway Project Signalling System
Model No.:	1.9.2.1.24
Test Standard:	IEC 62443-3-3: 2013+COR1: 2014
	Industrial communication networks – Network and system security – Part 3-3: System security requirements and security levels
Test Report Number(s):	GZES22040053301
Valid until:	2025-05-30

This Verification of Compliance has been granted to the applicant based on the results of tests, performed by Laboratory of SGS-CSTC Standards Technical Services Co., Ltd. on sample of the above-mentioned product in accordance with the provisions of the relevant specific standards.

David Guo
Senior Technical Manager
SGS-CSTC

2022-05-30

This verification is issued by the company under its General Conditions of Services accessible at http://www.sgs.com/en/terms-and-conditions. Attention is drawn to the limitations of liability defined therein and in the Test Report here above mentioned which findings are reflected in this verification. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law.

Member of SGS Group (Société Générale de Surveillance)

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Safety VOC-F197 Rev. 1.0 2022-06-30
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軌道交通領域全球首張IEC 62443網路安全認證證書
The world's first IEC 62443 cybersecurity certification in the rail transit sector.

International Information System Security Certification Consortium

The (ISC)² Board of Directors hereby awards

Sheng Hua

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James Packer - Secretary

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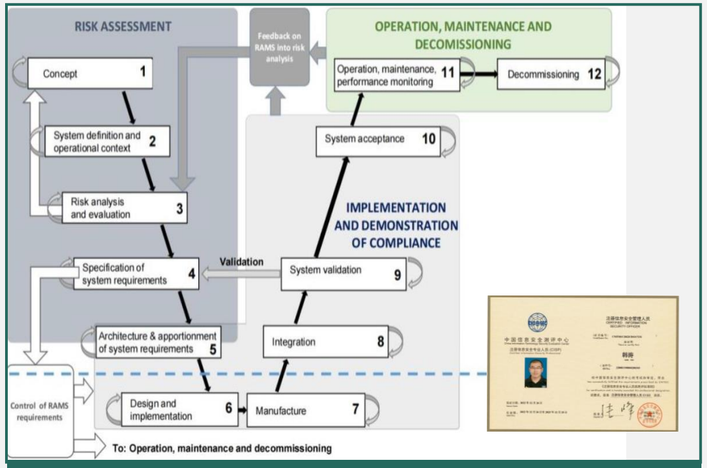
Printed On: 3/20/2023

相關工程師持有CISSP、CISP、CCSK等證書
Engineers with related certifications



參與PD CLC/TS 50701:2023標準轉換IEC63452工作

運營韌性時代的全域安全範式
HSP for the Era of Operational Resilience

$$H_s = \mathrm{F}_s * (1 + T^{\alpha} \cdot H^{\beta} \cdot \mathrm{O}^{\gamma} \cdot I^{\delta})$$

- H_s：全域安全 Holistic safety
- F_s：功能安全 Functional safety
- T：技術 Technology
- H：人文文化 Human & Cultural
- O：組織流程 Organizational &Process
- I：信息支柱 Information
- α,β,γ,δ：彈性係數 Elastic coefficient

HONG KONG, CHINA 2025
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INTERNATIONAL RAILWAY SAFETY COUNCIL

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