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Applying STPA to Analyse Risks in the Clearing House Automated Payment System (CHAPS)

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Agenda

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2 Research Problem & Objective
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Background

What is CHAPS?

- UK's high-value, Real-Time Gross Settlement (**RTGS**) system for GBP, operated by Bank of England (BOE)
  - RTGS: Payments are settled individually, not netted
- Handles **93%** of UK payment value
  (£367 billion/day) (BoE, 2021)
- Users: (BoE, 2024)
  - **Banks & Financial Institutions**: foreign exchange market, money market settlement…
  - **Corporates**: tax, payment to suppliers…
  - **Individuals**: buy houses, cars…
- Participants:
  - **38** Direct Participants : have a **settlement account** in BoE that can pay directly (HSBC, Barclays…)
  - Indirect Participants: access CHAPS via a Direct Participant

How CHAPS works?

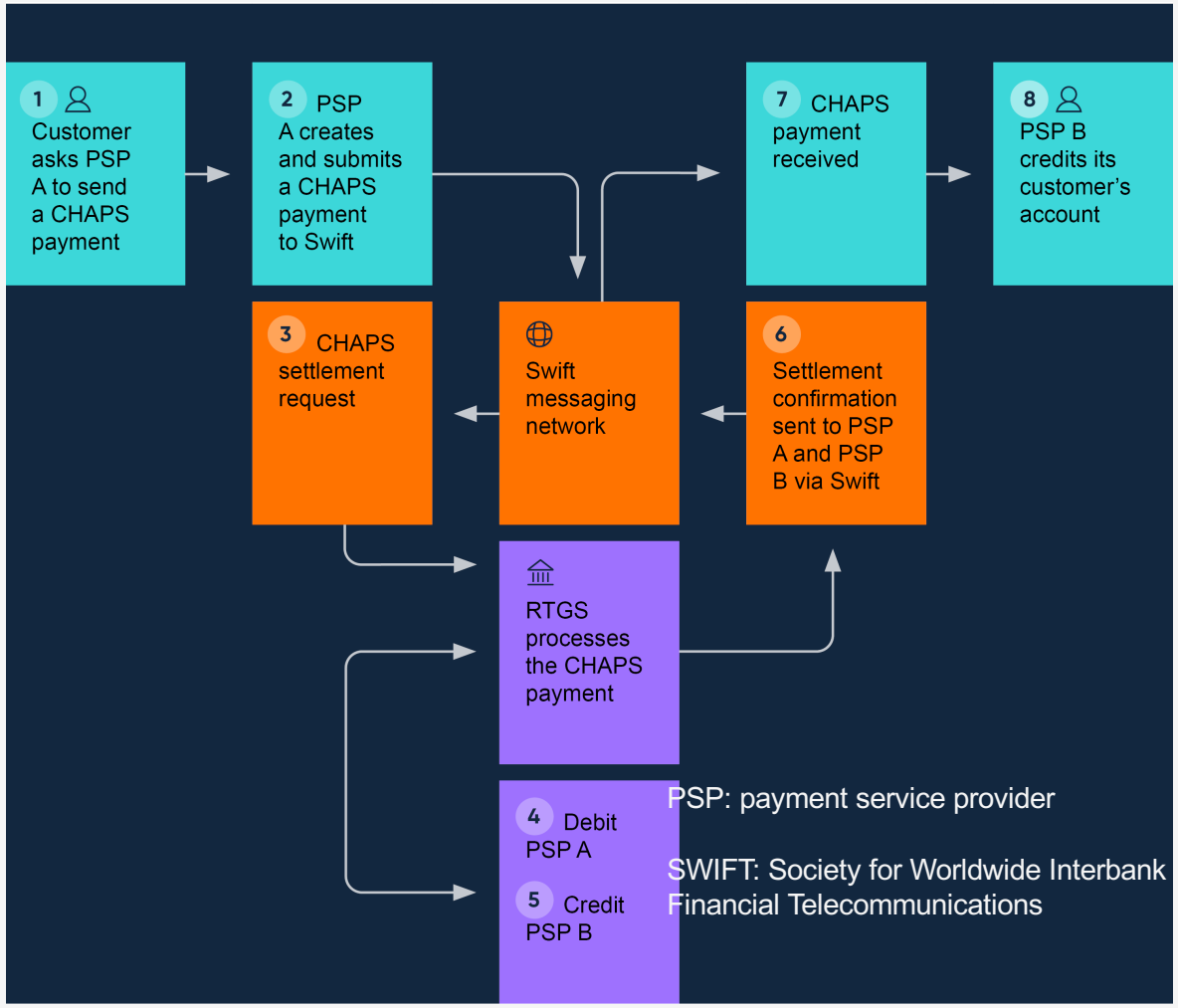


Figure1: Workflow of CHAPS (BoE, 2025a)

Background

Key Risks in CHAPS

Operational Risk: Human failures, system design defect

- The only **Broadly Observed** in 2023 BoE self-assessment (BoE, 2024)

Liquidity Risk: A participant lacks sufficient funds to settle CHAPS payments on time

- Common in all RTGS systems: Payments settle individually and immediately

Why traditional risk analysis is insufficient for CHAPS

- Focus on statistical outliers & linear causality
  → Assume independent components & ignore systemic interactions
- CHAPS is a socio-technical system
  → Involving human, technical & regulatory components

Traditional analysis can't capture systemic interactions of CHAPS

Research Method - STPA (Leveson, 2018)

- A system-theoretic hazard analysis method that identifies unsafe interactions and their causes in complex socio-technical systems
- Four steps



Research Problem

How can STPA be used to identify and mitigate Operational and Liquidity Risks in CHAPS?

Research Objectives

- Develop a control structure model of CHAPS
- Identify hazards, losses, Unsafe Control Actions (UCAs), scenarios leading to UCAs
- Propose practical mitigations for CHAPS

Define the purpose of the analysis

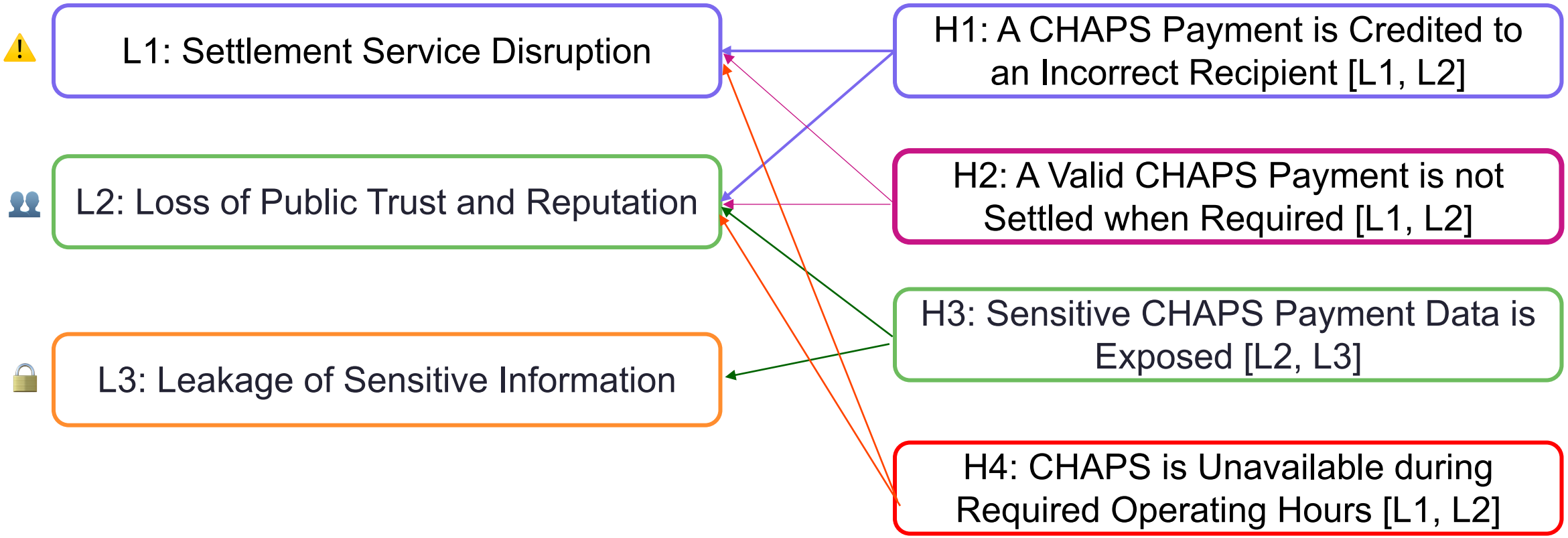
Defining the purpose of the analysis includes identifying losses and system-level hazards(Leveson, 2018)

Losses:

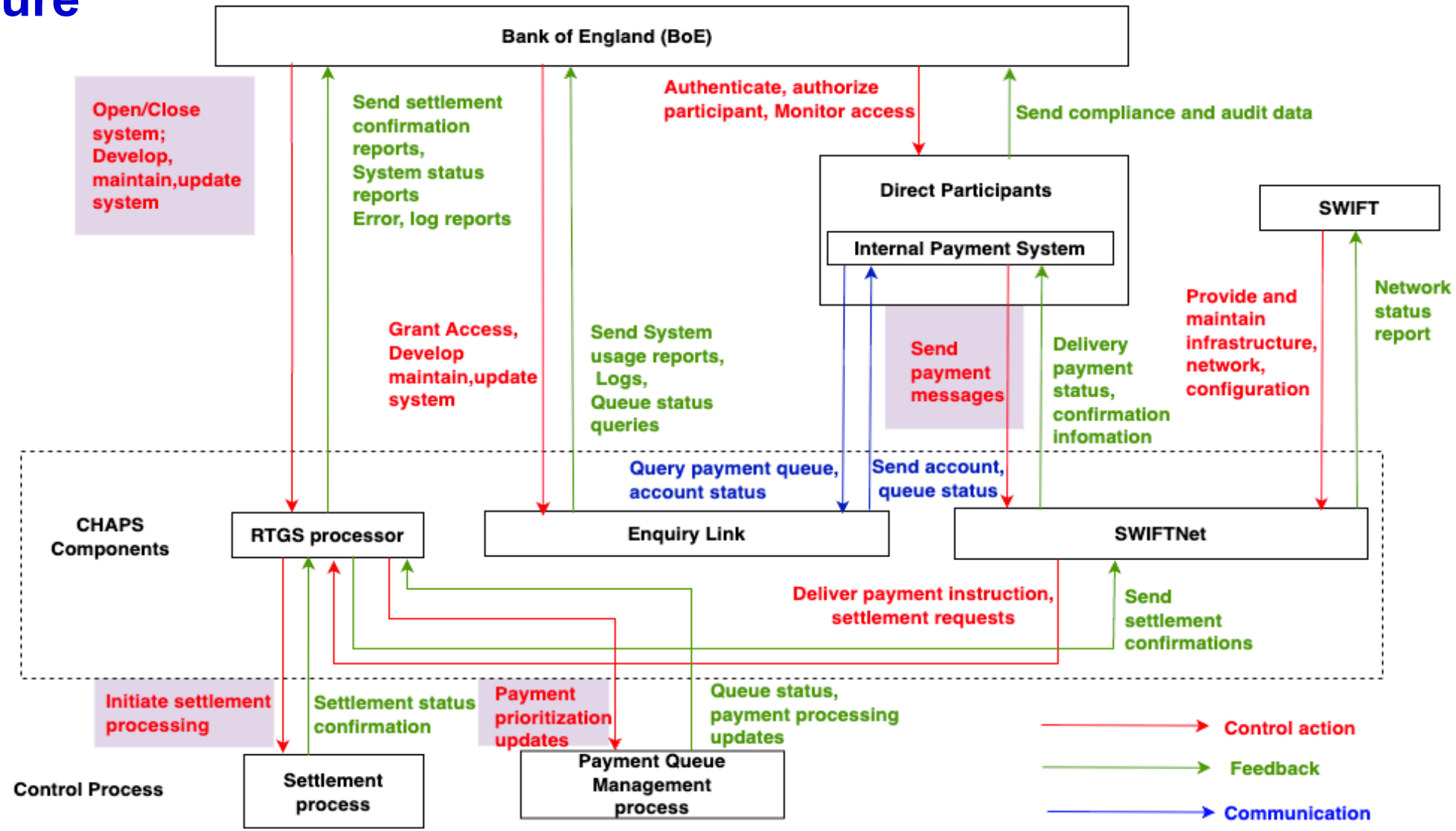
Something of value to stakeholders that is unacceptable if lost.

Hazards:

System condition that can cause a loss under worst-case environment



Control Structure

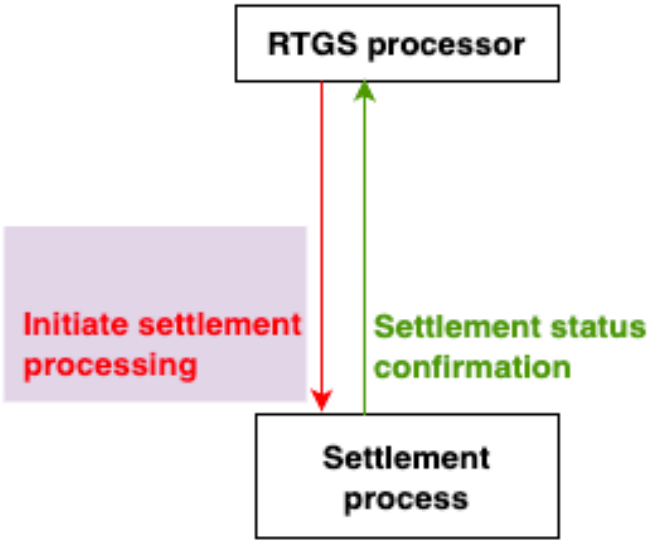


1*. RTGS Processor executes real-time gross settlement of CHAPS settlements between participants' accounts at the Bank of England.
2*. Enquiry Link is a tool provided by BoE that allows CHAPS Direct Participants to monitor their RTGS account balances and manage their payment queues in real time.
3*. SWIFTNet is the secure messaging network that routes CHAPS payment instructions between Direct Participants and the RTGS system for settlement.
4*. SWIFT is a network which provides the main messaging network through which international payments are initiated.

UCAs and Scenarios (Examples)

Control action: Initiate settlement process

Not providing causes hazard	Providing causes hazard	Too early, too late, out of order	Stopped too soon, applied too long
• **UCA-1**: The RTGS processor fails to initiate settlement when required. [H2, H4] • **Scenario:** Flaw in internal settlement algorithm blocks instructions from participants	No relevant UCA identified	• **UCA-2**: The RTGS processor initiates a settlement instruction when there is insufficient liquidity. [H2] • **Scenario:** Liquidity check uses outdated cache instead of real-time ledger	• **UCA-3**: The RTGS processor stops the settlement process before the settlement is finished. [H2] • **Scenario:** An error in the internal control algorithm mistakenly terminated the settlement.



Mitigations (Examples)

Liquidity Risk

✓Use **real-time ledger** checks instead of cached data
✓Establish **liquidity buffer thresholds** to block “just enough” funds

- **UCA-2:** The RTGS processor initiates a settlement instruction when there is insufficient liquidity. [H2]

Operational Risk

- ✓ Build in **automatic detection + manual start option** to avoid missed initiation
  - **UCA-1**: The RTGS processor fails to initiate settlement when required. [H2, H4]

- ✓ Add **automatic retry + manual override** to prevent premature stops
  - **UCA-3**: The RTGS processor stops the settlement process before the settlement is finished. [H2]

Discussion

Contributions

- First use of **STPA in CHAPS**
- Links **technical-human** risks
- Produces **traceable UCAs & mitigations**
- Extends **resilience methods to finance**



Limitations and Future work

- Reliance on BoE documents → Future: engage stakeholders to access **operational data**
- Focus only on key controllers → Future: extend analysis **to all control actions and scenarios**
- CHAPS as single case study → Future: compare with other RTGS systems (e.g., **Fedwire**)

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Thank you

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Reference

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