SW-STPA:
A Software Hazard Analysis Technique based on STPA

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INTRODUCTION

Introduction

- Importance of software safety increases
  - As the uses of software are various, software is germane to human's life and property.
- STAMP / STPA is powerful hazard analysis technique for system
  - Many case studies showed that.
- But, it has problems to apply software
  - Subject of STPA is 'system' which is large and complex.
- So, we propose SW-STPA
  - It is expected that SW-STPA helps developer have more various sights.

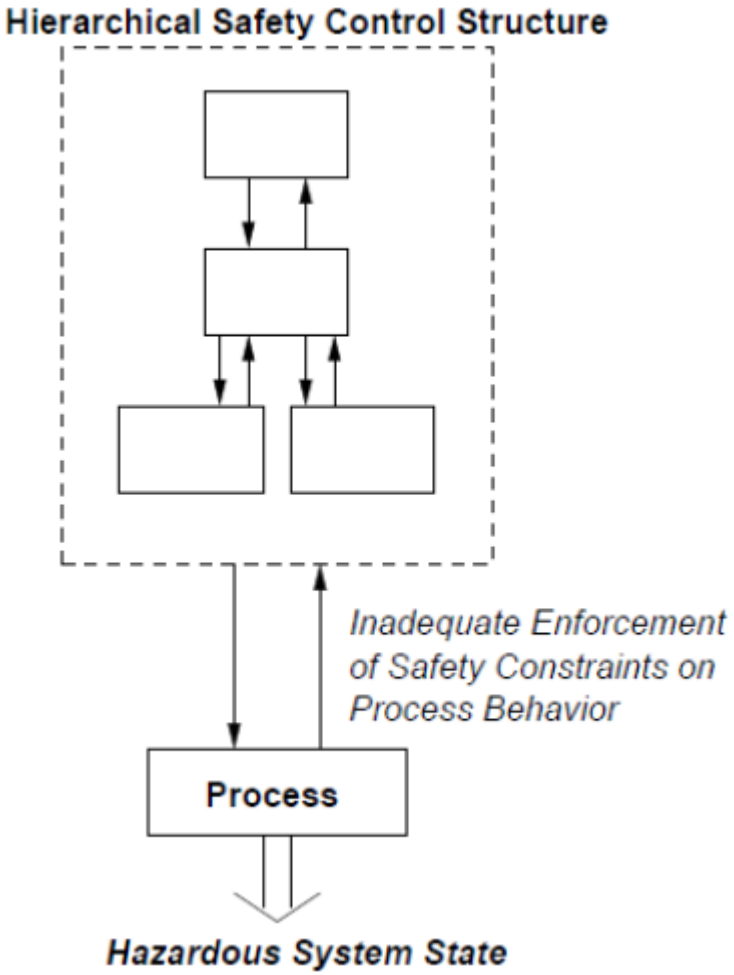
BACKGROUNDS

STAMP

STPA

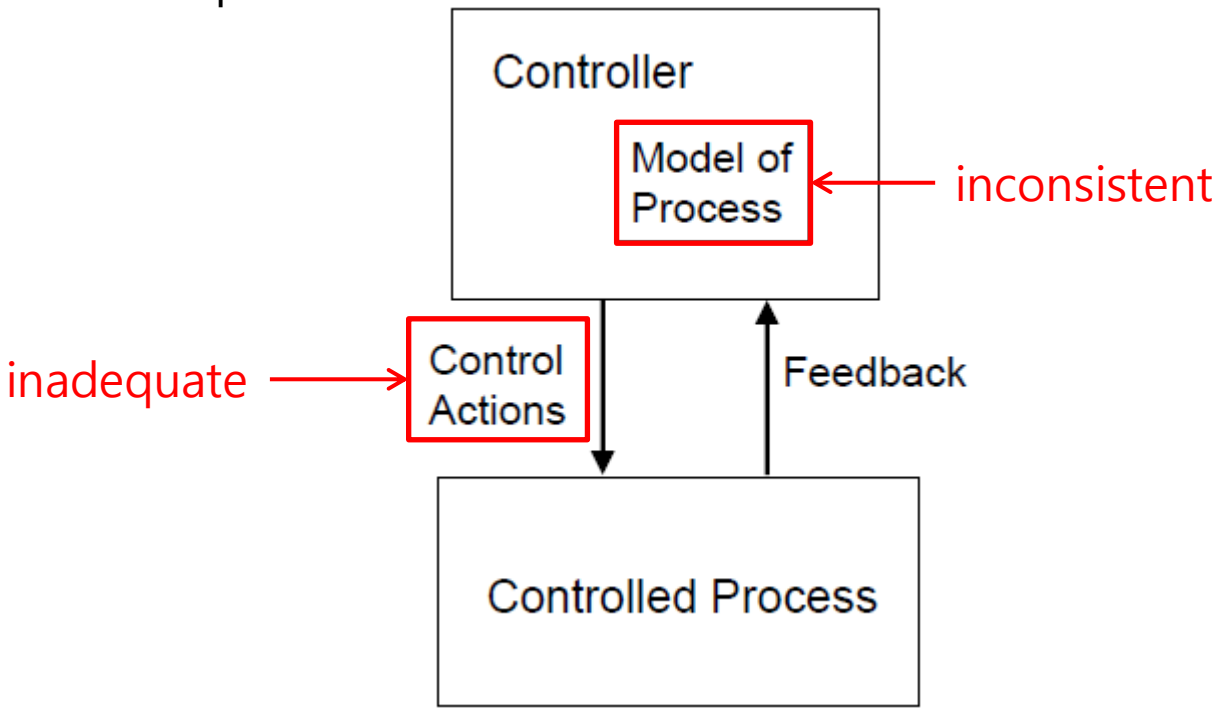
Backgrounds - STAMP

- Based on systems theory
- Treats accidents as a dynamic control problem
- Three basic concept
  - Safety constraints
  - Hierarchical safety control structure
  - Process model
- Includes
  - Entire socio-technical system
  - Component interaction accidents
  - Software and system design errors
  - Human errors



Backgrounds - STAMP

- Accidents occur when
  - Process model is inconsistent with real state of process and controller provides inadequate control actions



Control processes operate between levels of control

Backgrounds - STPA

- Goals
  - Identifying accident scenarios that encompass the entire accident process.
  - Providing guidance to users and information necessary to guide the design process and making it can be used before a design has been created.

- Uses
  - Control diagram
  - Functional requirements
  - System hazards
  - Safety constraints
  - Safety requirements for the component

Backgrounds - STPA

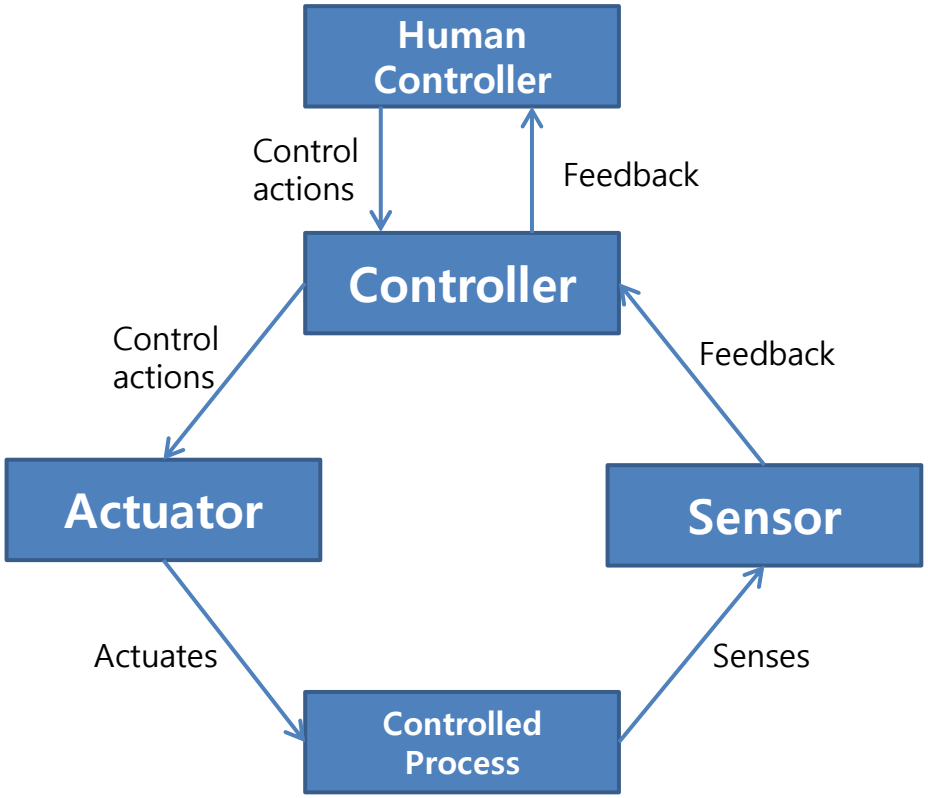
- Steps
  - Establish fundamentals
    - Defining accidents and unacceptable losses for system
    - System hazards
    - System safety requirements and constraints
    - Safety control structure

1. Identify the potential for inadequate control of the system that could lead to a hazardous state.

2. Determine how potentially hazardous control action identified in step 1 could occur.

Backgrounds - STPA

- General form of Safety control Structure
  - Human Controller
    - Operator of system.
  - Controller
    - Controller of system
  - Actuator
    - Actuates physical processes which are Controller ordered
  - Controlled Process
    - Physical controlled process
  - Sensor
    - Senses physical controlled process and gives feedback to Controller.



Backgrounds - STPA

- Four general types of inadequate control actions
  - Used in STPA Step 1.

Four general types

Control Action	Safety is not provided	Unsafe Action is provided	Wrong Timing / Order	Stopped too soon / too late
Start Radiation Exposure	1. Radiates to patient regardless of exposure criteria.	1. Exposure criteria is saved too high	-	-
Stop Radiation Exposure	-	-	1. Radiation is over the required amount. 2. Radiation is over the exposure limit for patient 3. Radiation is stopped although required amount for patient is not enough.	1. Radiation is over the exposure limit, but radiation stopped too late

Example of radiation exposure

SW-STPA

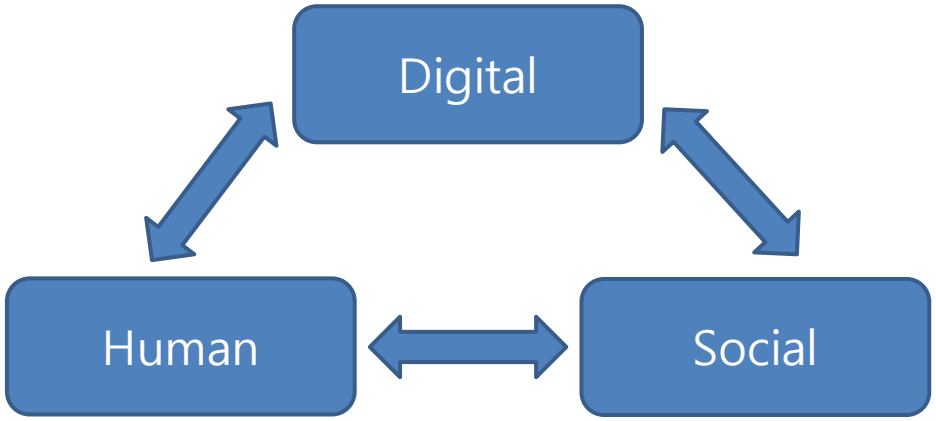
New general form of safety control structure

SW-STPA

- Subject of current SW-STPA
  - Not for embedded software, for stand-alone software.
  - For developed software. (Source codes are exist)

SW-STPA

- Difference of components
  - Components in STPA
    - Electromechanical, digital, human, social
  - Components in SW-STPA
    - Digital, human, social

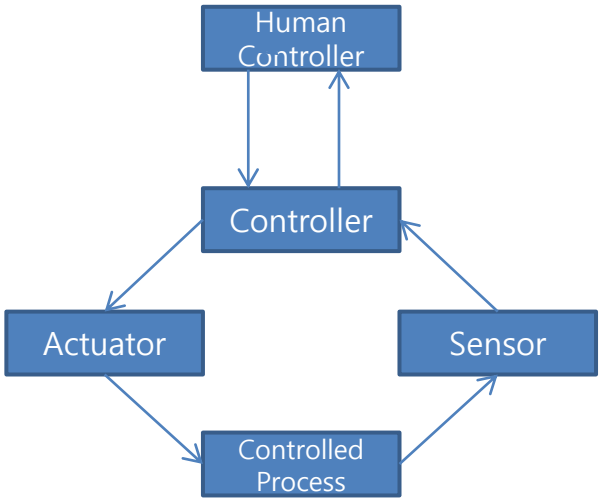


Components and interactions in SW-STPA

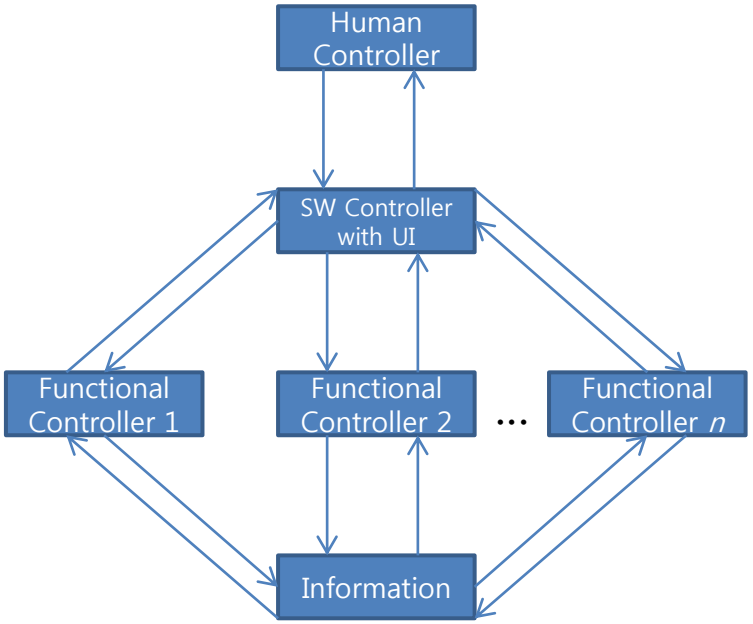
SW-STPA

- New general form of safety control structure
  - Differences between STPA vs. SW-STPA

STPA

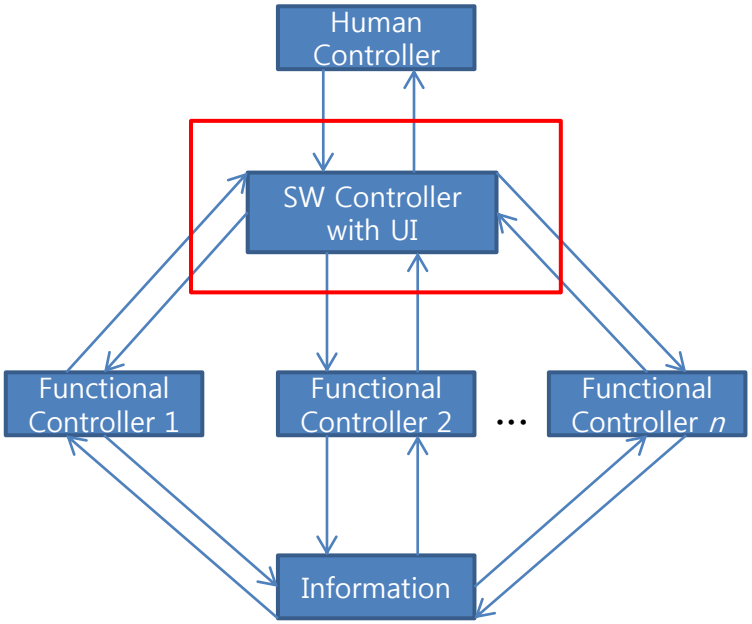


SW-STPA



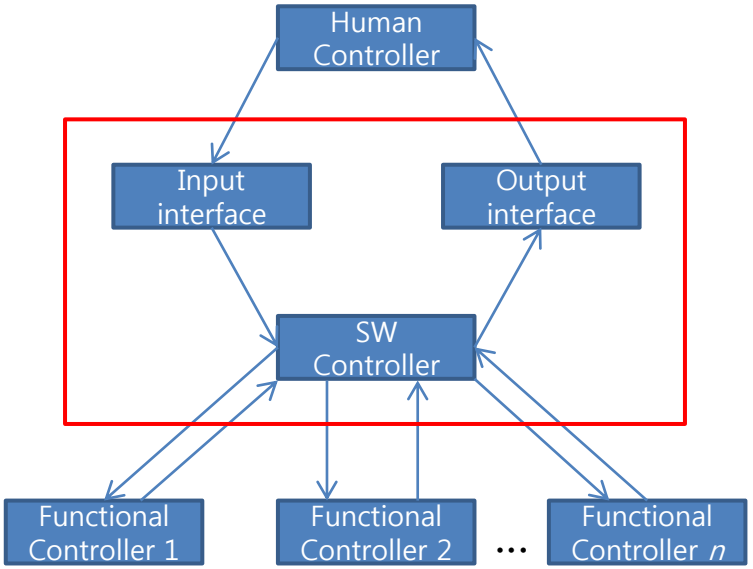
Safety Control Structure in SW-STPA

- SW Controller with UI
  - Composed of Input interface, Output interface, SW Controller
  - Interacts with Human Controller
  - Gives control actions to functional controllers



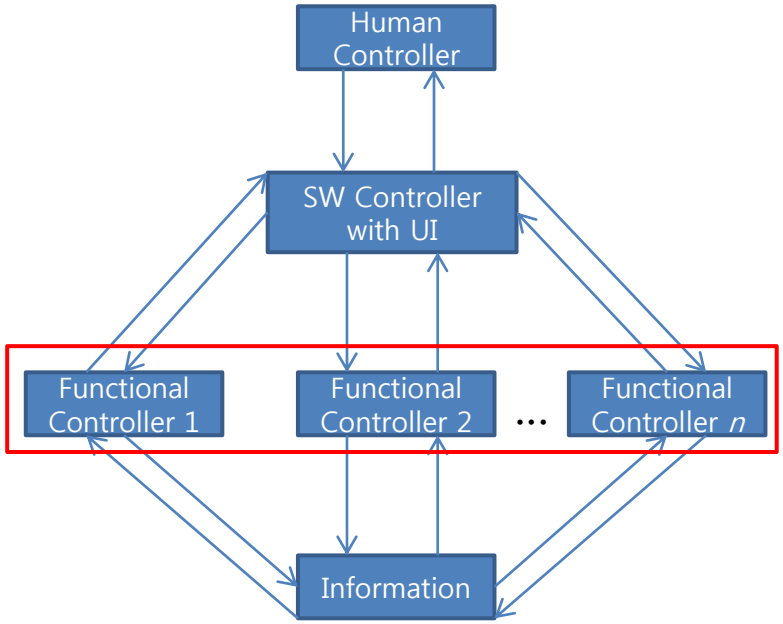
Safety Control Structure in SW-STPA

- SW Controller
  - UI
    - Input interface
      - Delivers Human Controller's control actions to SW Controller
    - Output interface
      - Gives Result of control actions to Human Controller
  - SW Controller
    - Inputs + process model → decision
    - Gives control actions to functional controllers
    - Gives results to Output interface



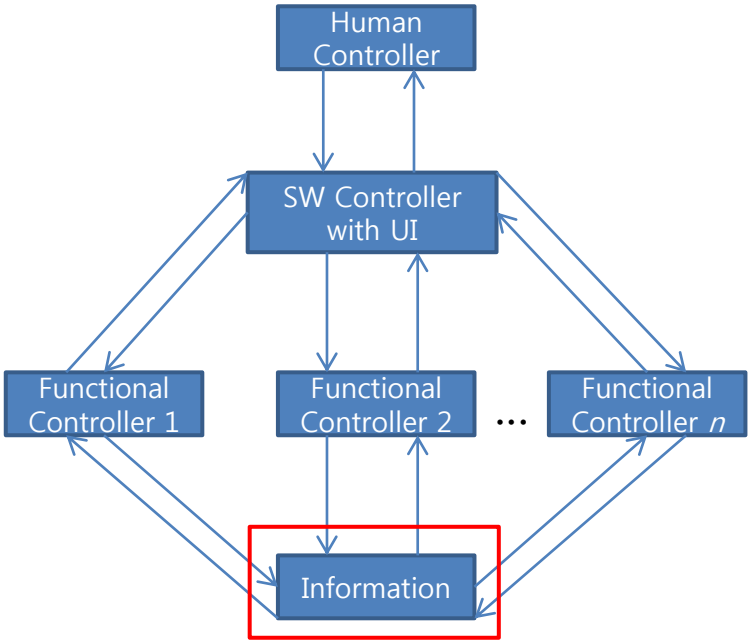
Safety Control Structure in SW-STPA

- Functional Controller *n*
  - Describes each function in software
  - Ex>Digital Watch – Stop watch, Alarm, …
  - Subject is software, not system
    - Each functional controller has to check what it did and gives feedback to SW Controller
  - Can be separated to small functional controllers.



Safety Control Structure in SW-STPA

- Information
  - STPA : Physical process vs. SW-STPA : Information
  - Subject is software, not system
    - There is no physical process in software
  - Information contains all of information which are changed, created, deleted by functional controllers



CASE STUDY: FBDTOC

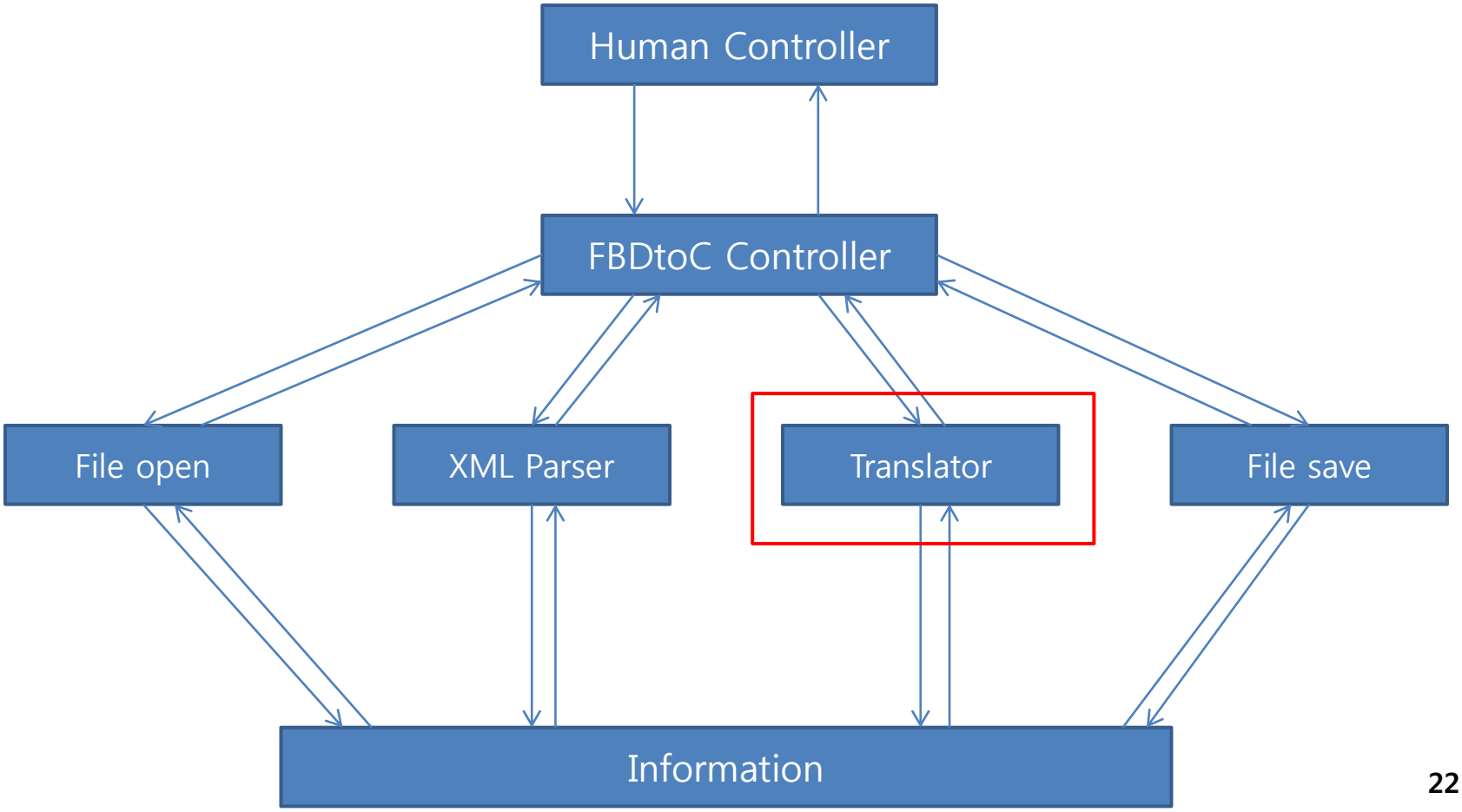
Safety control structure of FBDtoC

Case Study: FBDtoC

- FBDtoC
  - Simple translator we developed
  - Functions
    - Open FBD file (in XML)
    - Translate FBD into C language
    - Save C file

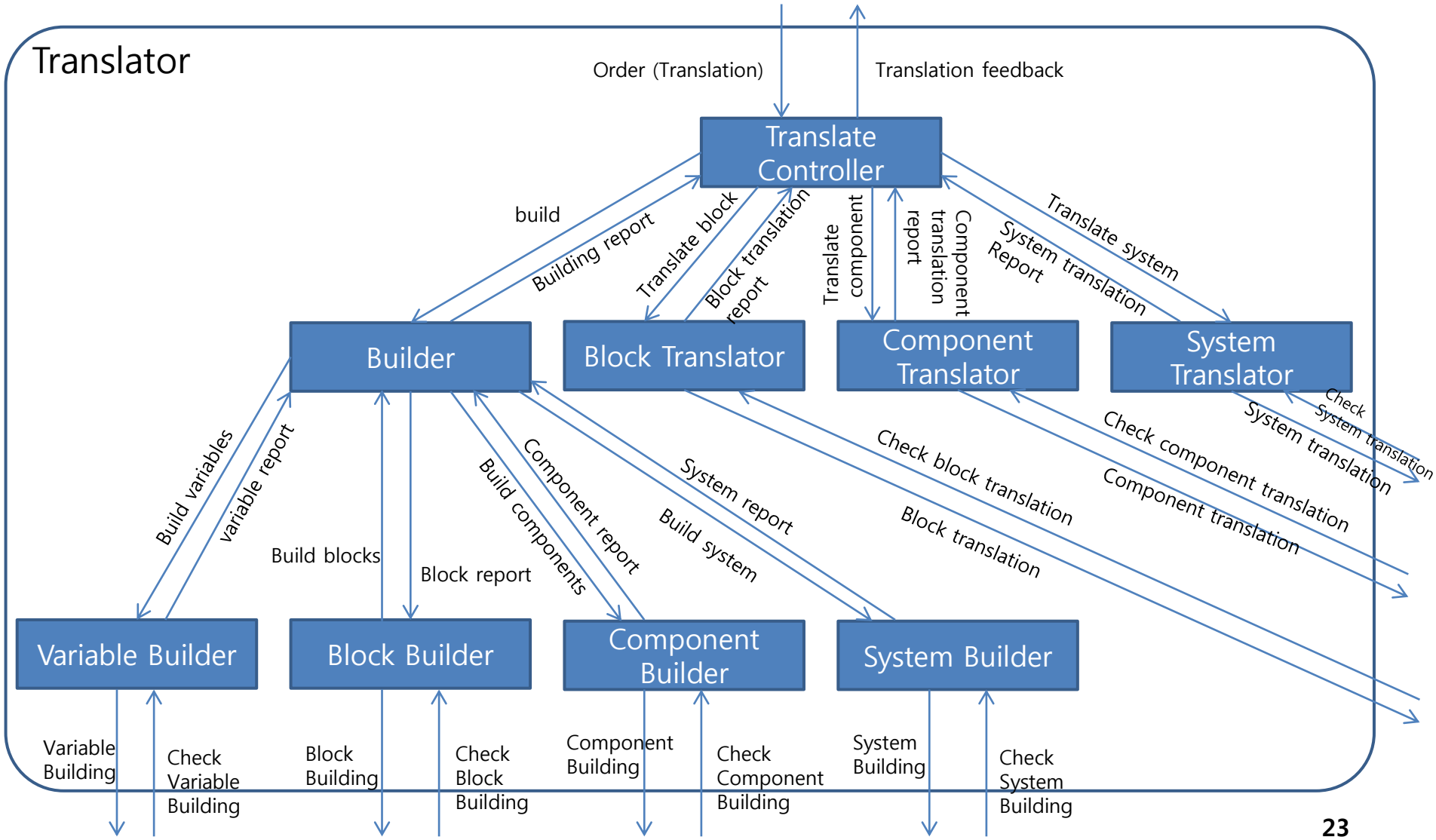
Case Study: FBDtoC

- Safety Control Structure lv.1



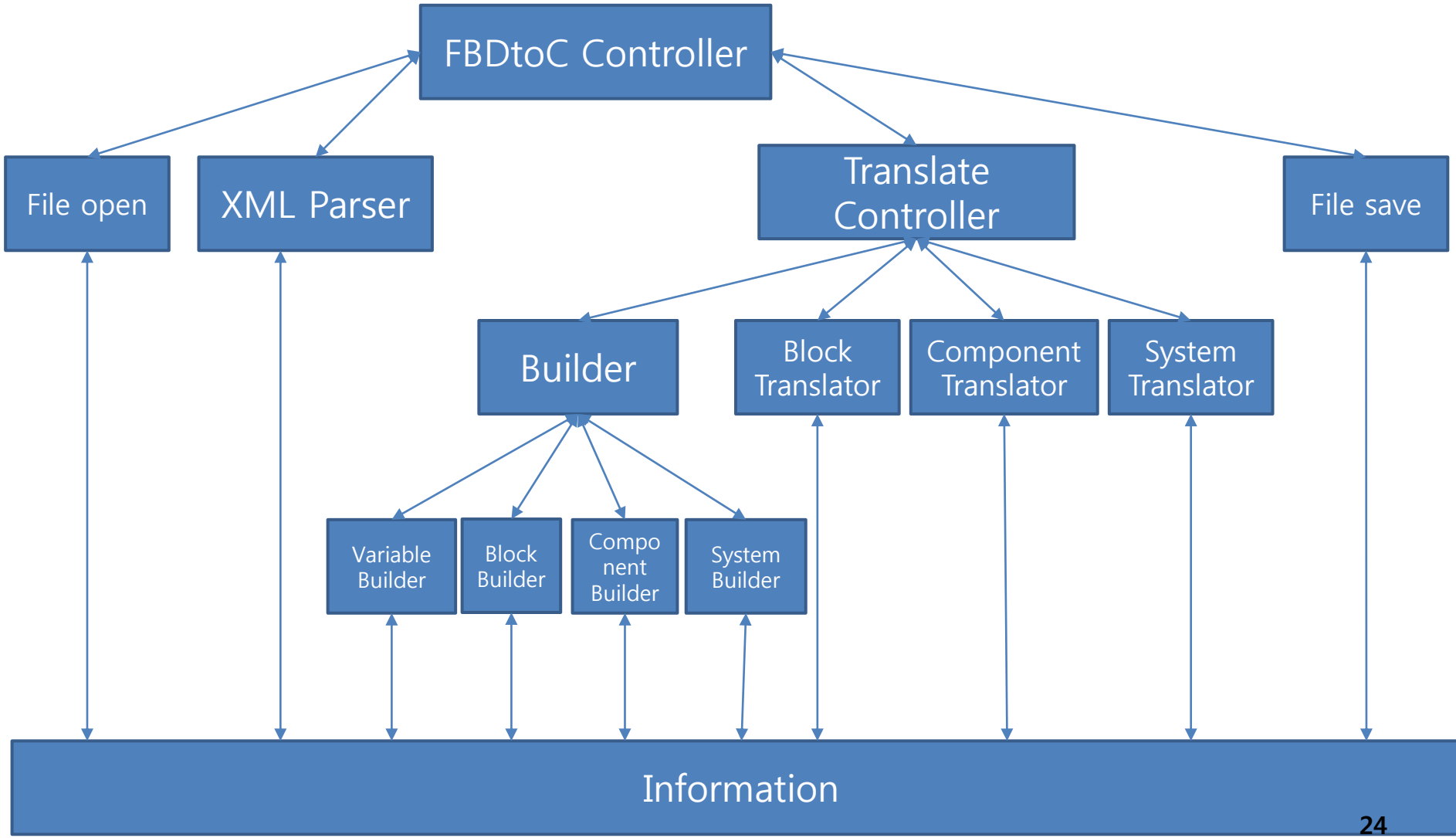
Case Study: FBDtoC

- Safety Control Structure lv.2 (Translator)



Case Study: FBDtoC

- Safety Control Structure



CONCLUSION & FUTURE WORK

Conclusion & Future work

- Conclusion
  - STAMP/STPA is powerful hazard analysis technique for system
  - But it has problems applying STPA to software because of difference of subject
  - We propose SW-STPA and new general form of safety control structure.
  - And we described FBDtoC with SW-STPA, we developed.

- Future work
  - We will develop SW-STPA Step 2. for developed software.
    - How to describe process model for software controllers?
  - We will compare SW-STPA with other hazard analysis technique.

Thank you
Q & A

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