



intercax

# Model-Based Systems Engineering for Electronic Voting System Security

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## Georgia moves to replace hackable electronic voting

Senators: Extent of Russian election intrusion still unknown



Voters fill out their ballots at the Cincinnati Public Library precinct on primary election day, Tuesday, May 8, 2018, in Cincinnati. Ohio's roller-coaster gubernatorial primary season will be decided Tuesday as Republicans and Democrats vote for their nominees to replace term-limited Republican Gov. John Kasich. (AP Photo/John Minchillo)

Posted: 7:35 p.m. Tuesday, May 08, 2018

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Hi, Theagirl

## FBI investigating alleged breach in Georgia at KSU's elections

WASHINGTON — The United States still doesn't know — and may never know — the extent of Russian interference in state election systems in 2016, according to bipartisan findings released Tuesday by the Senate intelligence committee. Lawmakers say they do know the U.S. is still vulnerable to such an attack.

The Senate committee made the findings public ahead of the panel's full election security report, which is expected to be released in the coming weeks. The document provides new details about the level of Russian activity during the last presidential election.

The committee found that in at least six states "Russian-affiliated cyber actors" conducted "malicious access attempts on voting-related websites" that went beyond routine scanning previously reported. In a majority of those cases, the Russians used a common hacking technique to attack the states' public-facing election websites. The committee didn't identify the six states.

The Federal Bureau of Investigation is investigating an alleged data breach in Georgia at the Center for Election Systems at Kennesaw State University, The Atlanta Journal-Constitution has learned.

2

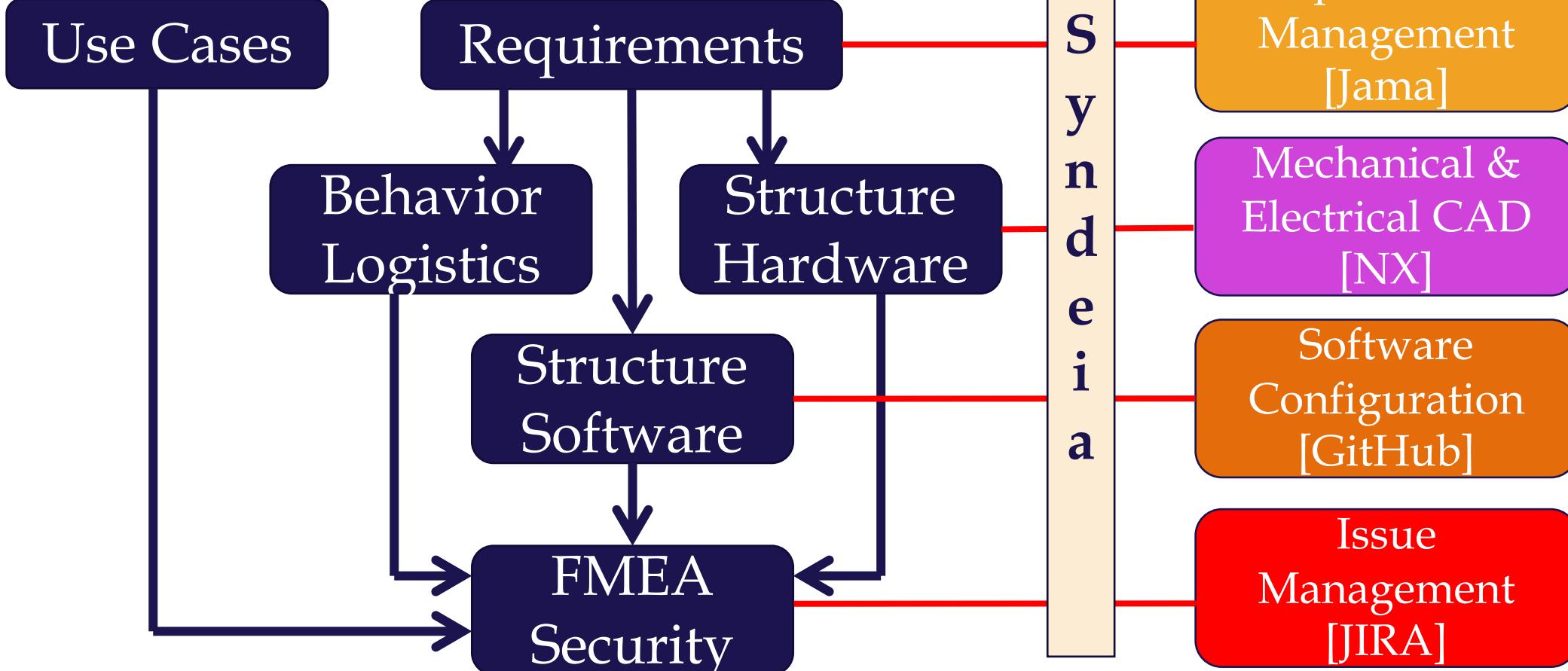
Man rushed to hospital after shooting in Buckhead



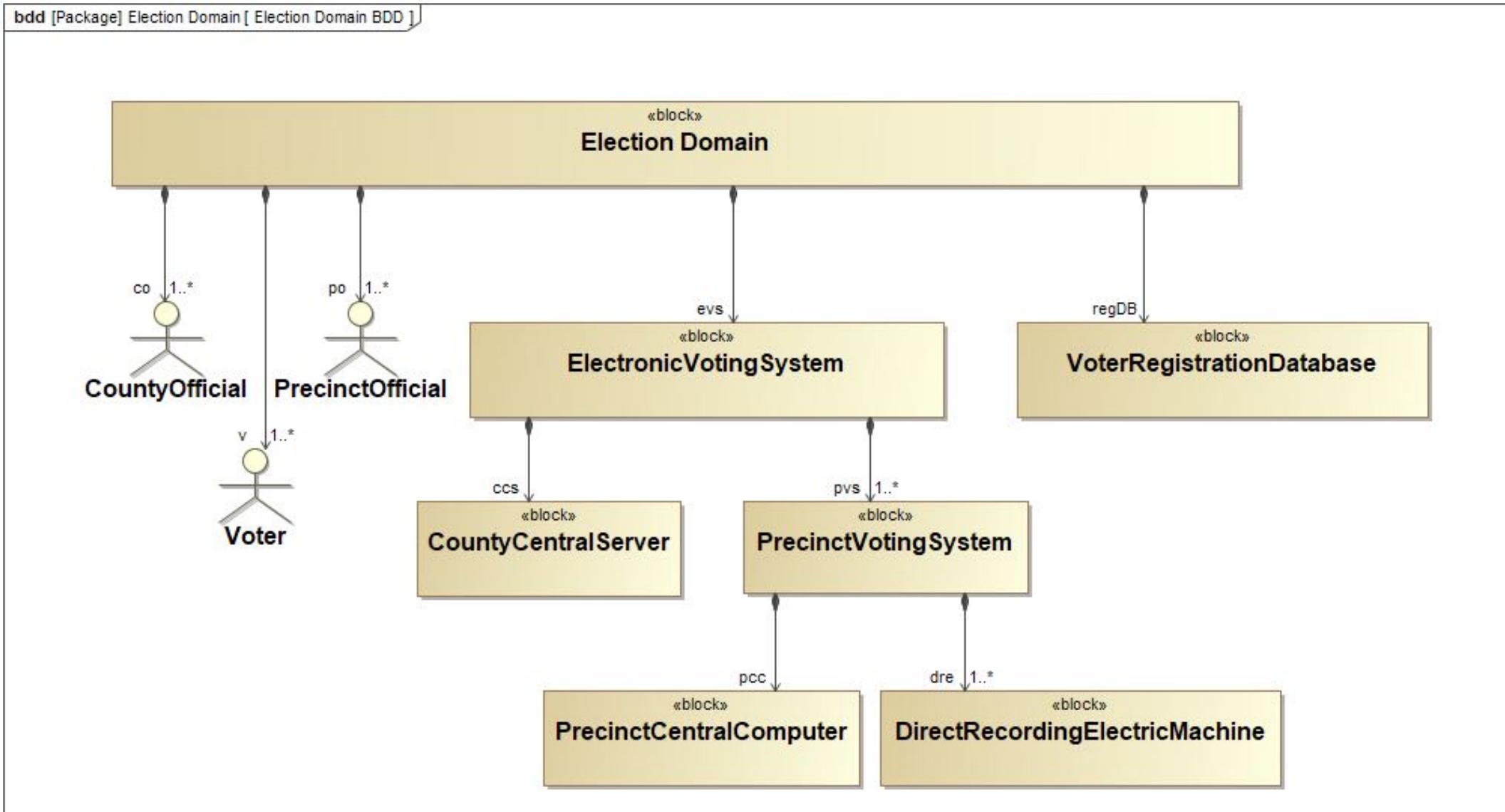
- MBSE provides a clear and self-consistent specification of EVS requirements, hardware, software, process and logistics
- MBSE allows for the systematic definition of failure modes for security analysis
- MBSE provides a framework for connecting multiple models in different software tools and building a unified roadmap of the system



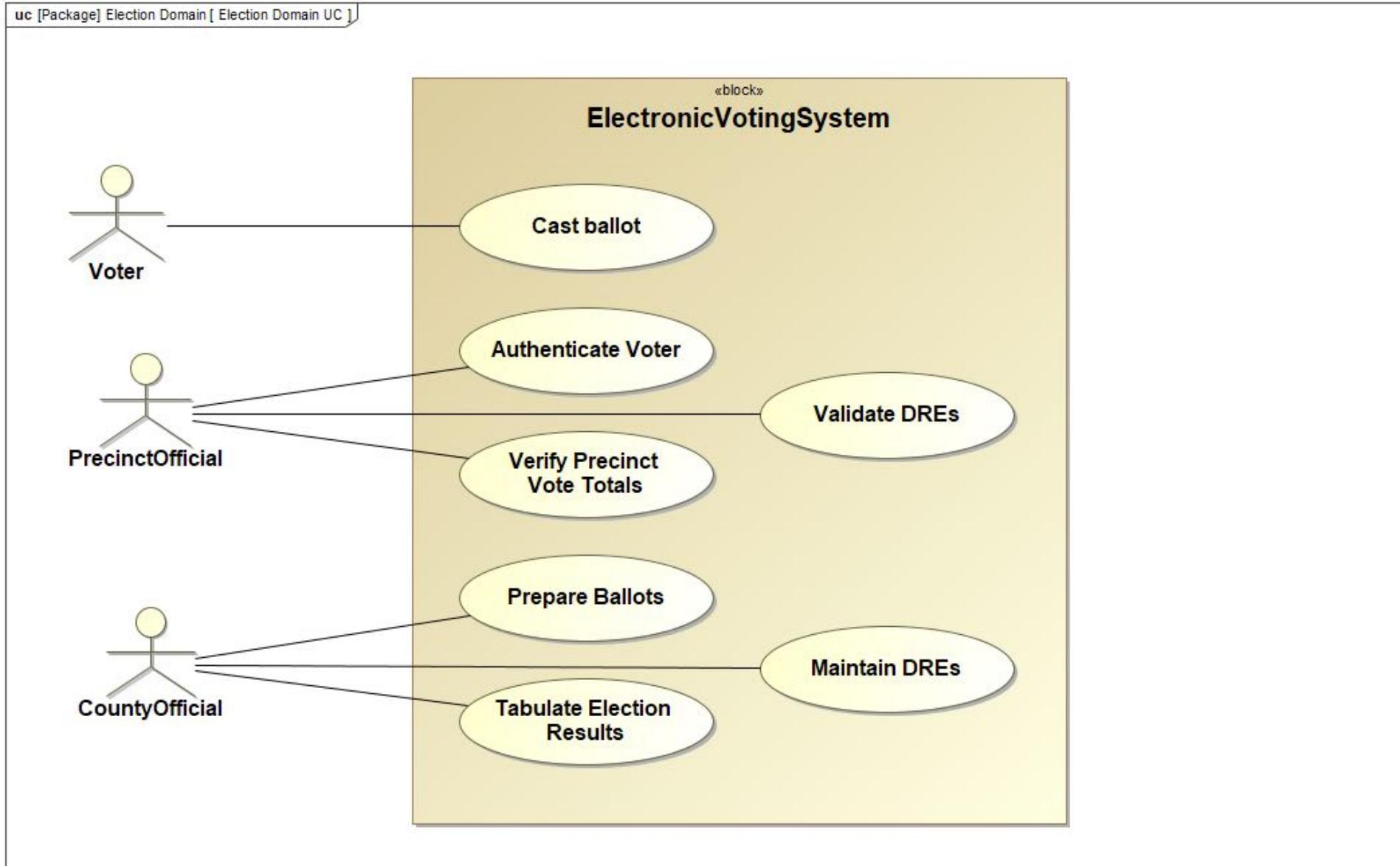
- SysML [MagicDraw]



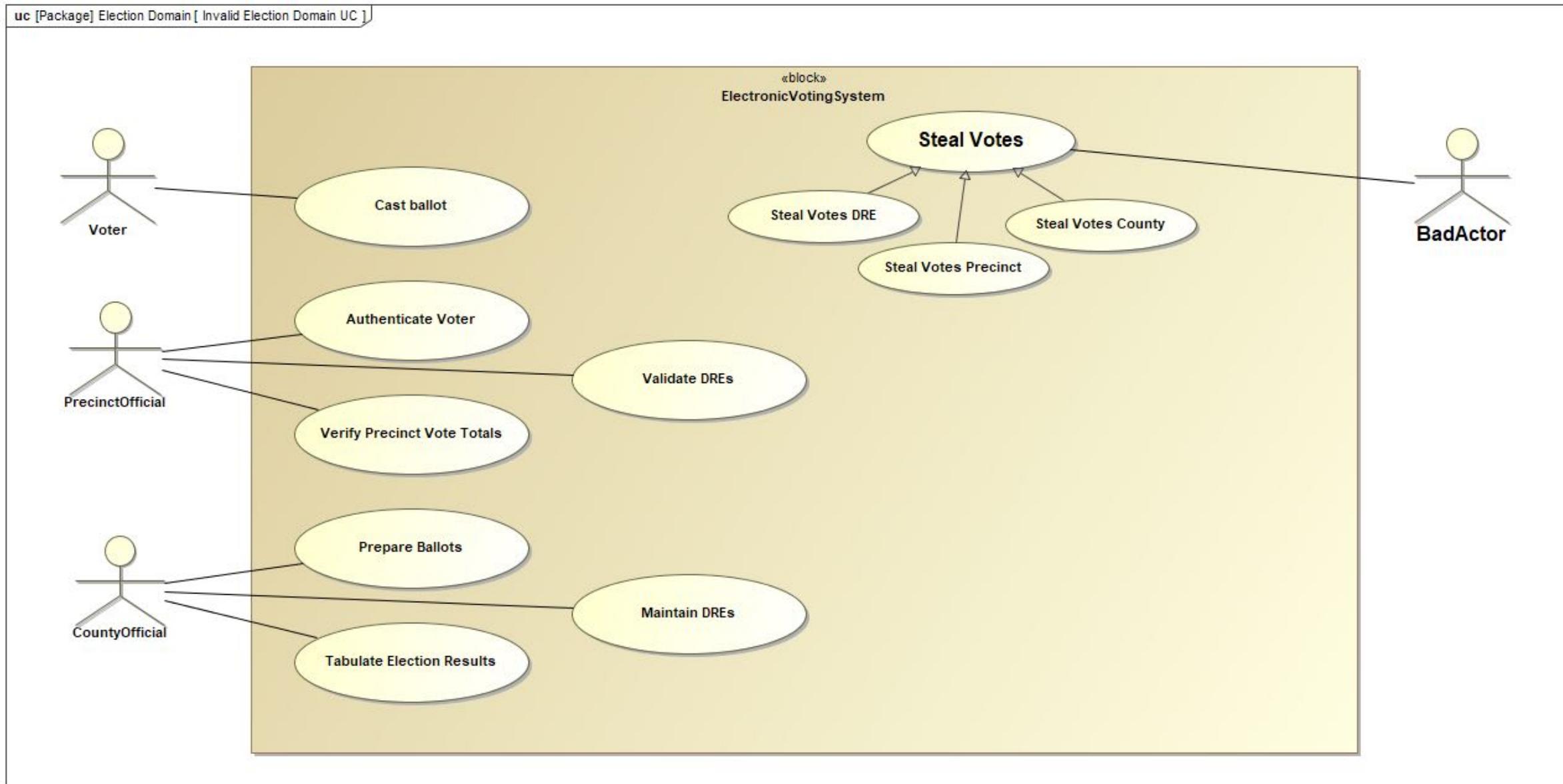
# Electronic Voting System Structure



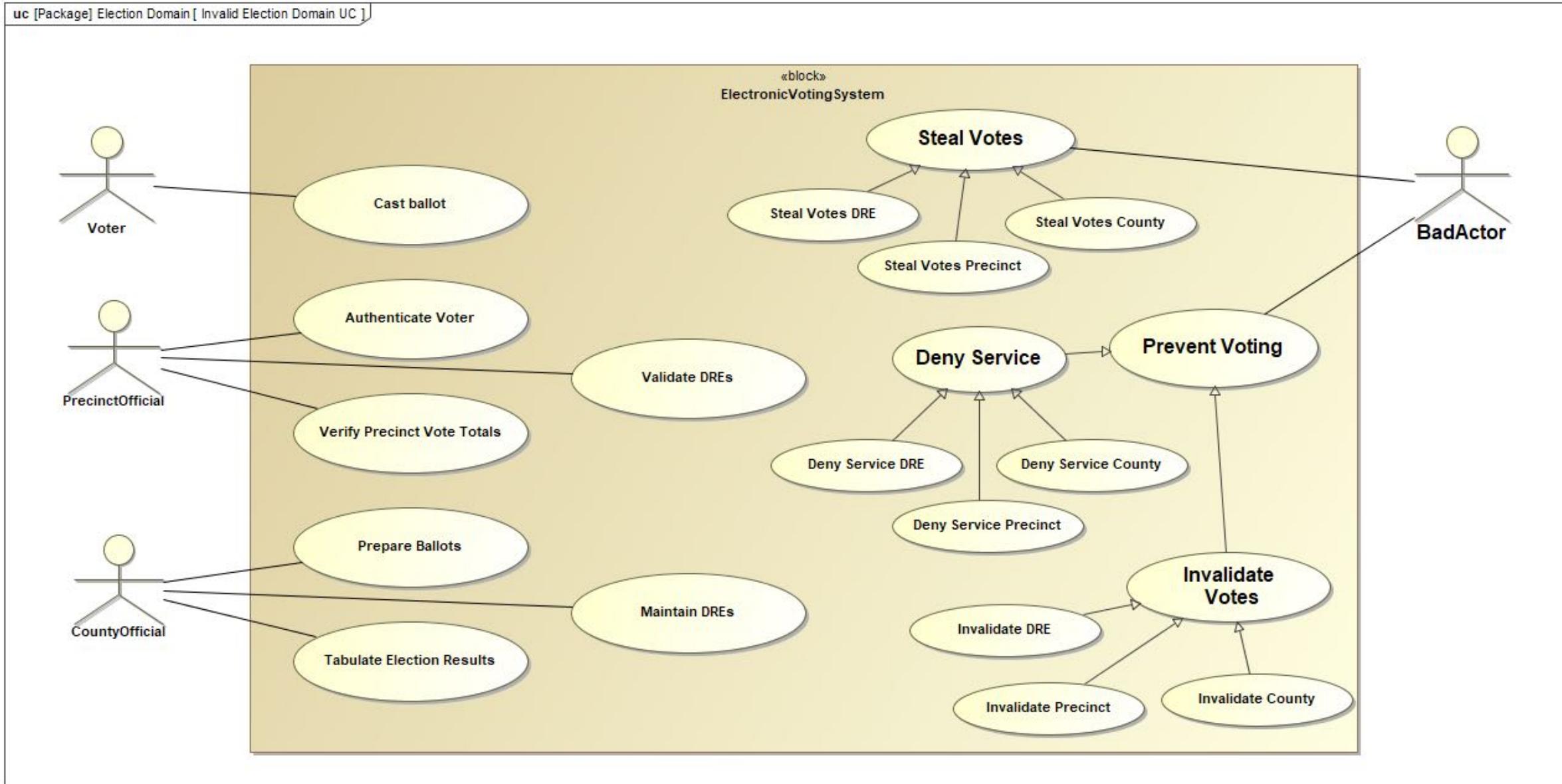
# Electronic Voting System Use Cases



# Electronic Voting System Use Cases

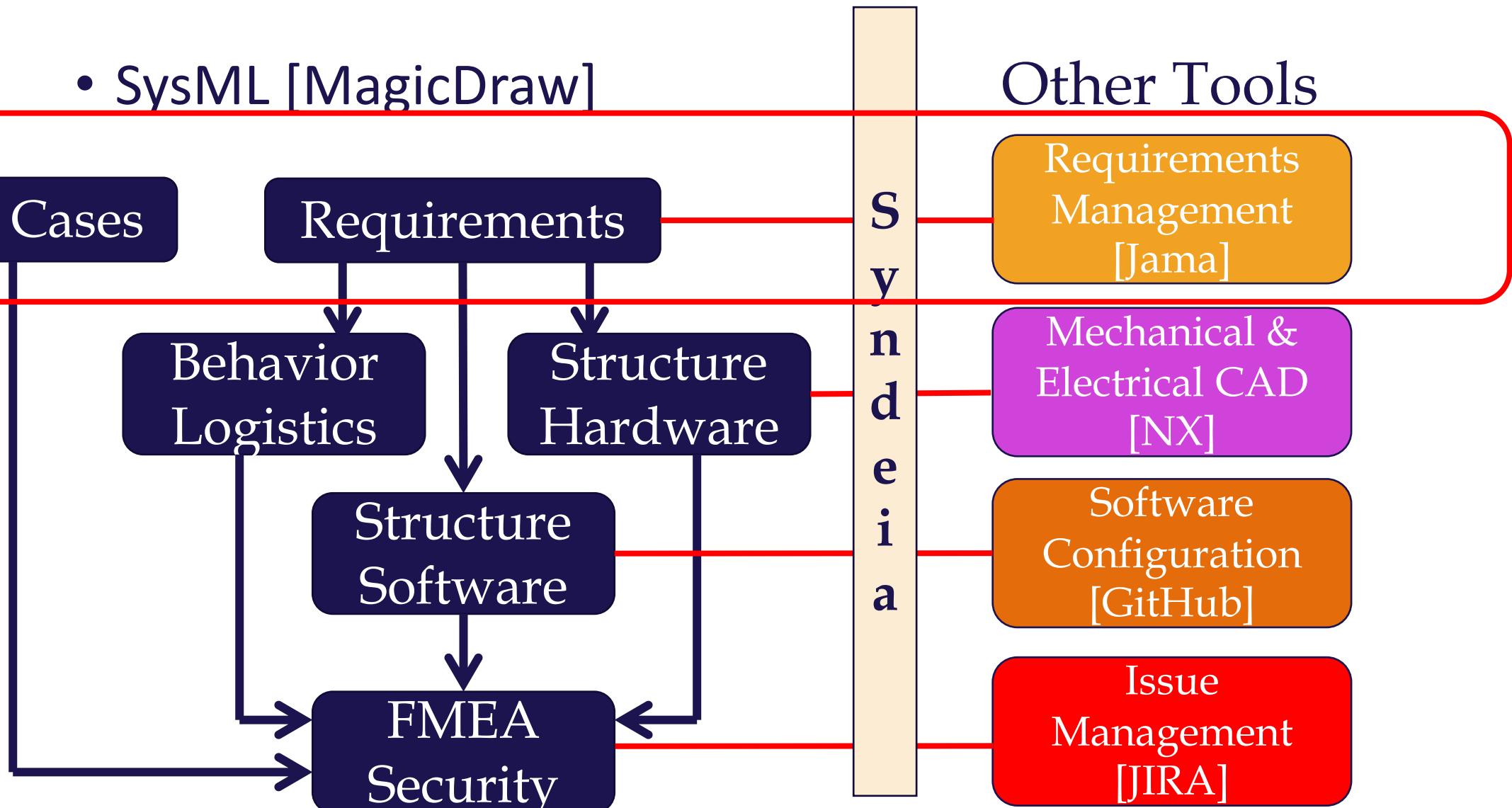


# Electronic Voting System Use Cases





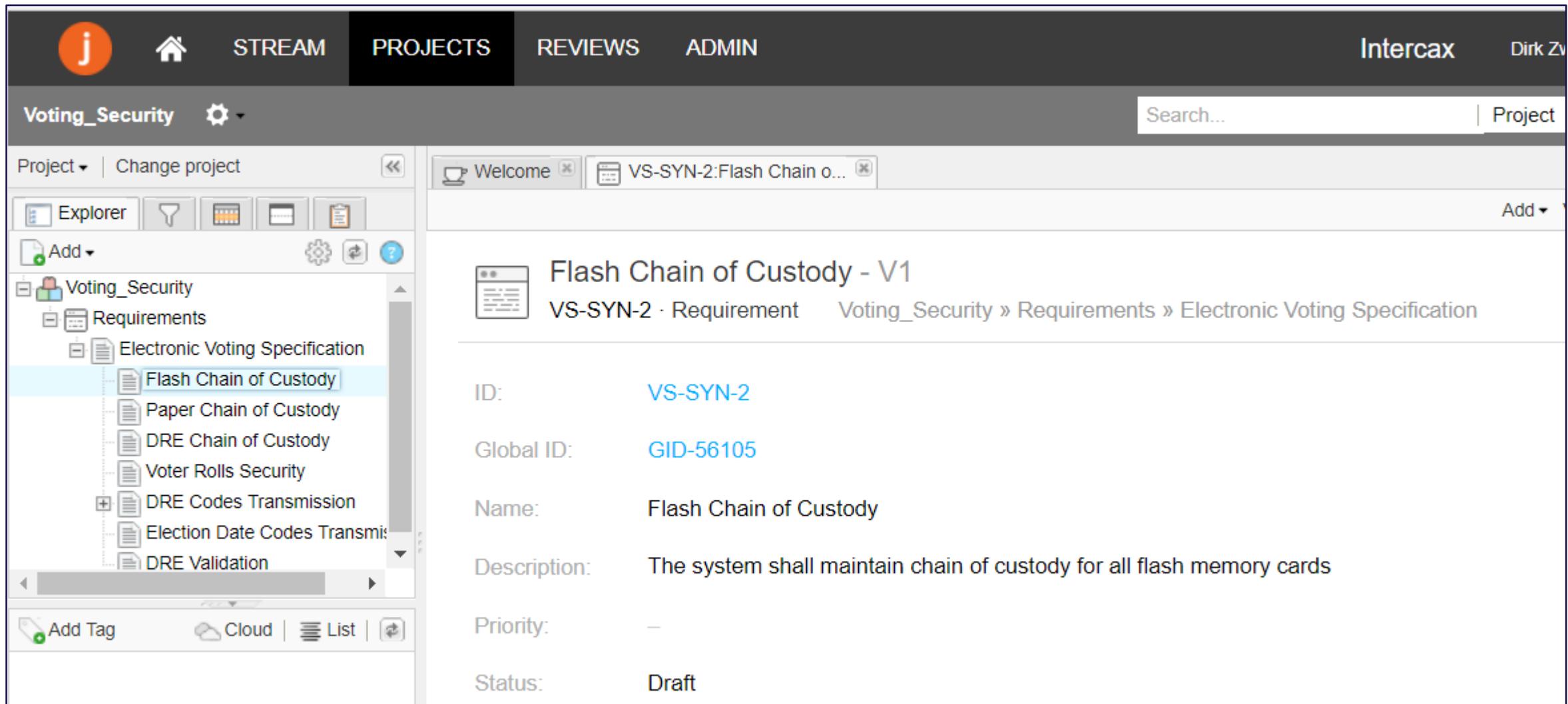
- SysML [MagicDraw]



# Electronic Voting System Requirements



Populated from Requirements Management Repository (Jama) by Syndeia (Intercax)



The screenshot shows the Jama Requirements Management Repository interface. The top navigation bar includes a 'j' logo, 'STREAM', 'PROJECTS' (which is selected), 'REVIEWS', 'ADMIN', and user names 'Intercax' and 'Dirk Zv'. The left sidebar shows a project structure under 'Voting\_Security': 'Voting\_Security' (selected), 'Requirements', 'Electronic Voting Specification' (selected), 'Flash Chain of Custody' (selected), 'Paper Chain of Custody', 'DRE Chain of Custody', 'Voter Rolls Security', 'DRE Codes Transmission', 'Election Date Codes Transmission', and 'DRE Validation'. The main content area displays the requirement details for 'Flash Chain of Custody - V1' (VS-SYN-2). The requirement ID is VS-SYN-2, Global ID is GID-56105, Name is Flash Chain of Custody, Description is 'The system shall maintain chain of custody for all flash memory cards', Priority is listed as '—', and Status is 'Draft'. The top navigation bar also includes a 'Search...' field and a 'Project' dropdown.

Flash Chain of Custody - V1

VS-SYN-2 · Requirement   Voting\_Security » Requirements » Electronic Voting Specification

ID: VS-SYN-2

Global ID: GID-56105

Name: Flash Chain of Custody

Description: The system shall maintain chain of custody for all flash memory cards

Priority: —

Status: Draft

# Electronic Voting System Requirements



Populated from Requirements Management Repository (Jama) by Syndesia (Intercax)

S Syndesia 3.2.0 - Dirk Sandbox 03 (DZSB03) - Cloud store (storeman2.intercax.com)

Repository Manager Connection Manager Connection Browser Connection Search Comparison Result Mappings

Repository	Connection Type	Jama @ Intercax.com
VotingSystem	Model Transform	TestForJama
Election Domain		Unmanned Aerial Vehicle
ElectronicVotingSystem		Voting_Security
Requirements		Requirements
Electronic Voting Specification		Electronic Voting Specification
Flash Chain of Custody		Flash Chain of Custody
Paper Chain of Custody		Paper Chain of Custody
DRE Chain of Custody		DRE Chain of Custody
Voter Rolls Security		Voter Rolls Security
DRE Codes Transmission		DRE Codes Transmission
Election Date Codes Transmission		Election Date Codes Transmission
DRE Validation		DRE Validation
SecurityAnalysis		Washing_Machine

Search Repository

Ready 3:31:14 PM 512M of 1262M

# Electronic Voting System Requirements



Populated from Requirements Management Repository (Jama) by Syndeia (Intercax)

MagicDraw 18.5 - VotingSystem\_v6.mdzip [D:\Egnyte\Shared\Publications\Papers and Presentations\2018-07\_INCOSE IS 2018 Wash DC\Voting Systems Presentation\1\_Draft\_Presentation]

File Edit View Layout Diagrams Options Tools Analyze Collaborate Window Help

Diagrams Containment Structure Create Diagram

Election Domain UC Invalid Election Domain ... Setup\_Election Test and Validate DRE FMEA DRE Composition BDD Requirements DRE\_Modes Election

Containment

Model Relations

- ISO-80000 [ISO-80000.mdzip]
- MD Customization for Requirements [MD\_Customization\_for\_Requirements.mdzip]
- MD Customization for SysML [MD\_customization\_for\_SysML.mdzip]
- MD Customization for ViewsViewpoints [MD\_customization\_for\_Visuals.mdzip]
- UML Standard Profile [UML\_Standard\_Profile.mdzip]

VotingSystem

- Election Domain
- ElectronicVotingSystem
- Requirements
- Traceability of Safety And Reliability Analysis
  - Election REQ
  - Requirements
  - GID-56104 Electronic Voting Specification
    - GID-56105 Flash Chain of Custody
    - GID-56106 Paper Chain of Custody
    - GID-56107 DRE Chain of Custody
    - GID-56108 Voter Rolls Security
    - GID-56109 DRE Codes Transmission
    - GID-56111 Election Date Codes Transmission
    - GID-56112 DRE Validation
- SecurityAnalysis
- VotingSystemLibrary
- VotingSystem
- VotingSystem PKG
- FMEA\_profile [FMEA\_Profile.mdzip]
- Syndeia\_Profile [Syndeia\_Profile.mdzip]

Criteria

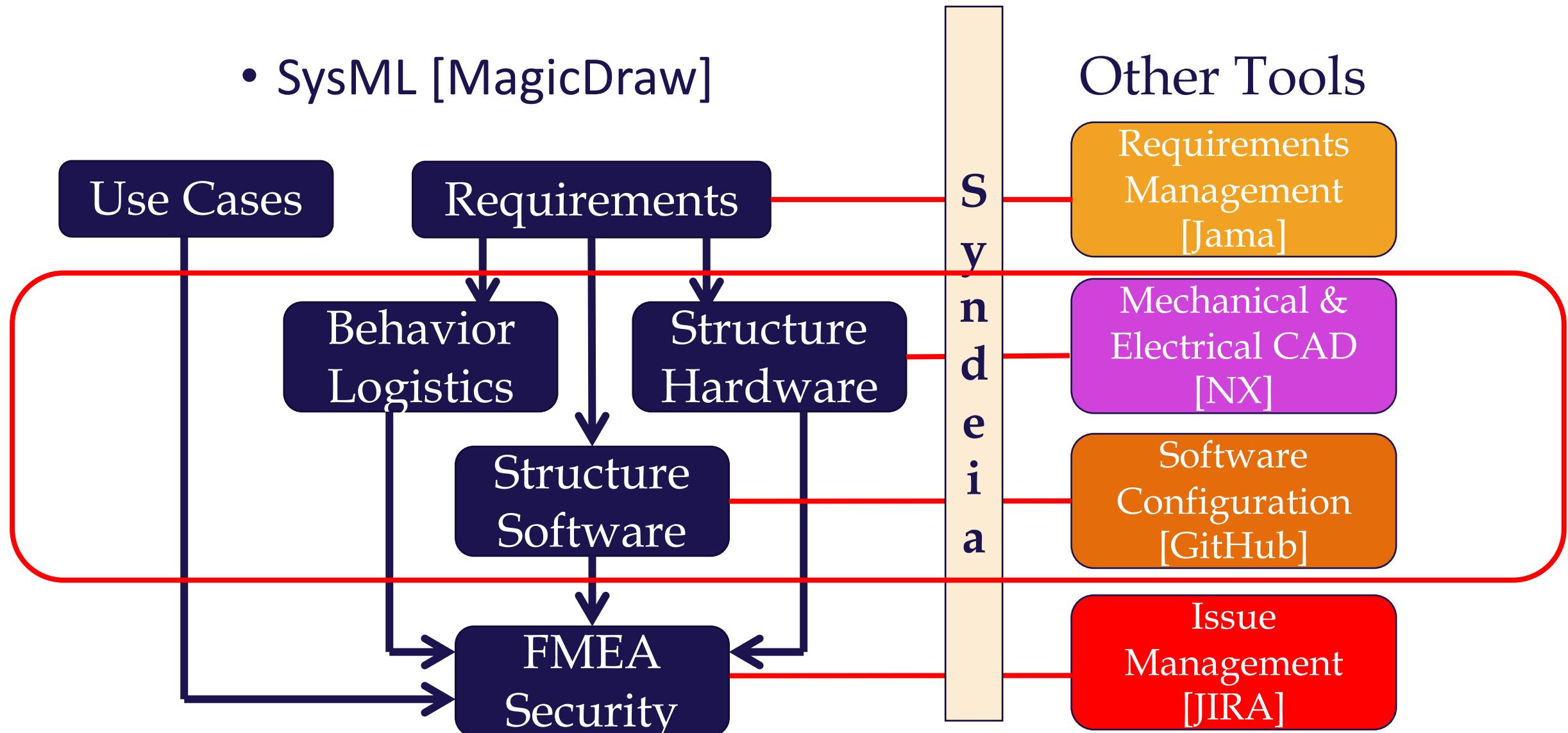
Scope (optional): Drag elements from the Model Browser

Filter:

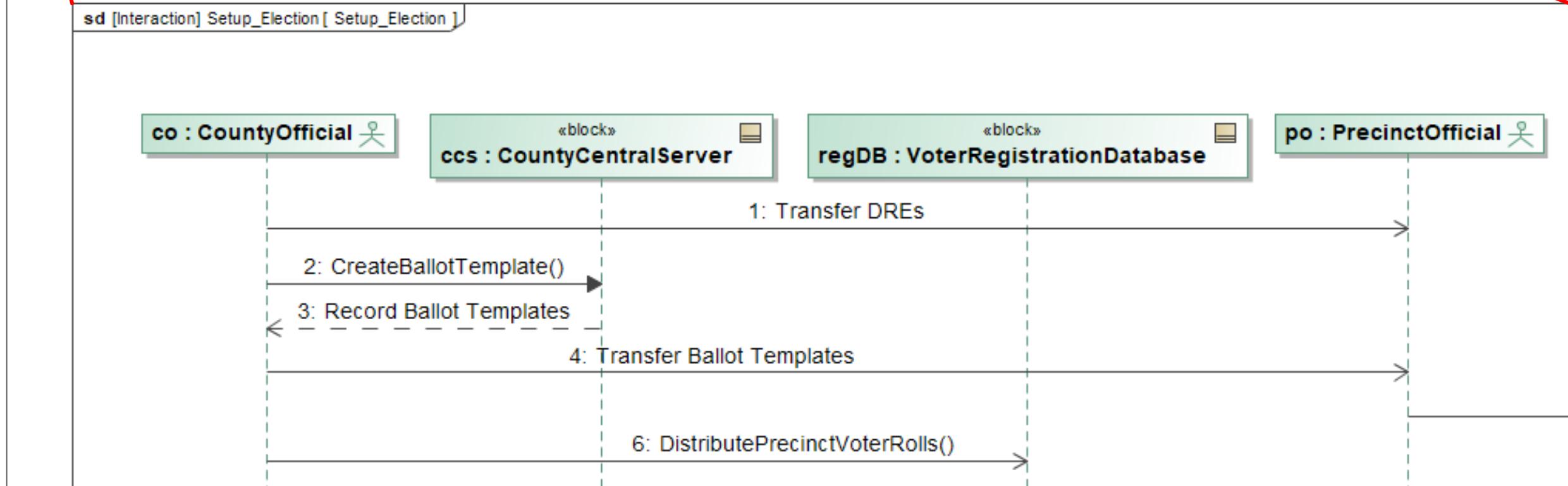
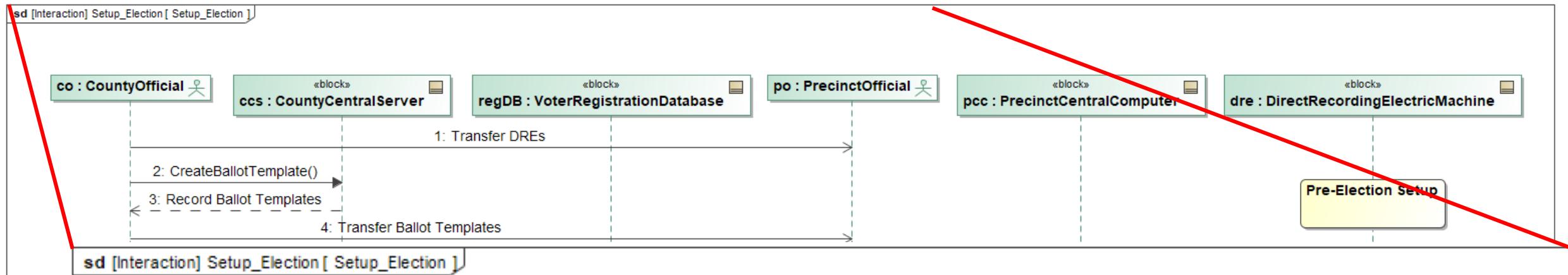
#	Name	Text
1	GID-56104 Electronic Voting Specification	
2	GID-56105 Flash Chain of Custody	The system shall maintain chain of custody for all flash memory cards
3	GID-56106 Paper Chain of Custody	The system shall maintain chain of custody for all paper documentation
4	GID-56107 DRE Chain of Custody	The system shall maintain chain of custody for all DRE voting machines.
5	GID-56108 Voter Rolls Security	The system shall use secure authentication methods for voter roll transmission.
6	GID-56109 DRE Codes Transmission	The system shall include specific DRE activation, start and end codes with precinct ballot data on flash memory card.
7	GID-56110 DRE Codes Encryption	The system shall encrypt DRE activation, start and end codes with precinct ballot data on flash memory card.
8	GID-56111 Election Date Codes Transmission	The system shall include specific DRE election date codes with precinct ballot data on flash memory card.
9	GID-56112 DRE Validation	The system will validate all DREs at each precinct location before polls open on election day.



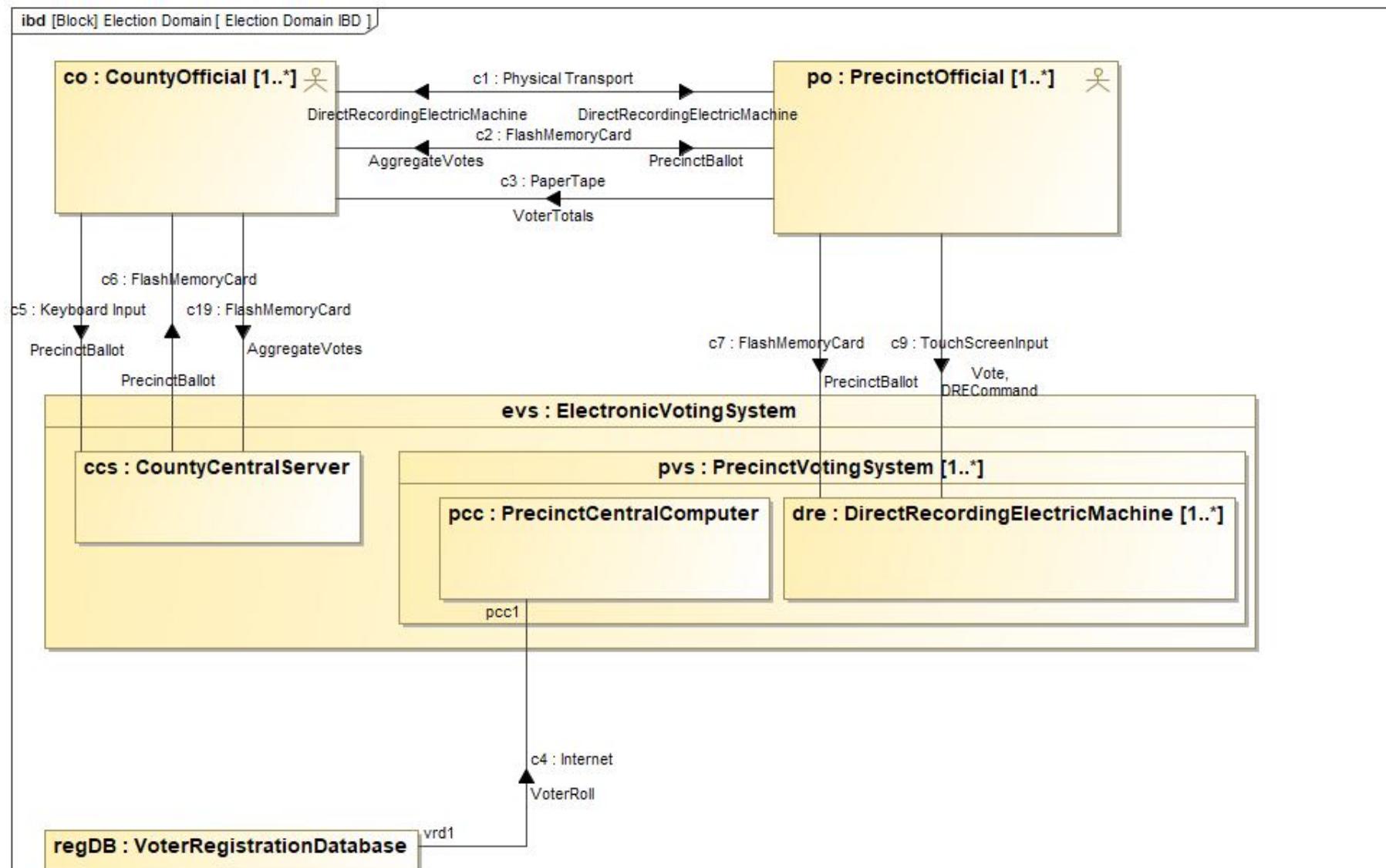
- SysML [MagicDraw]



# Electronic Voting System Operations



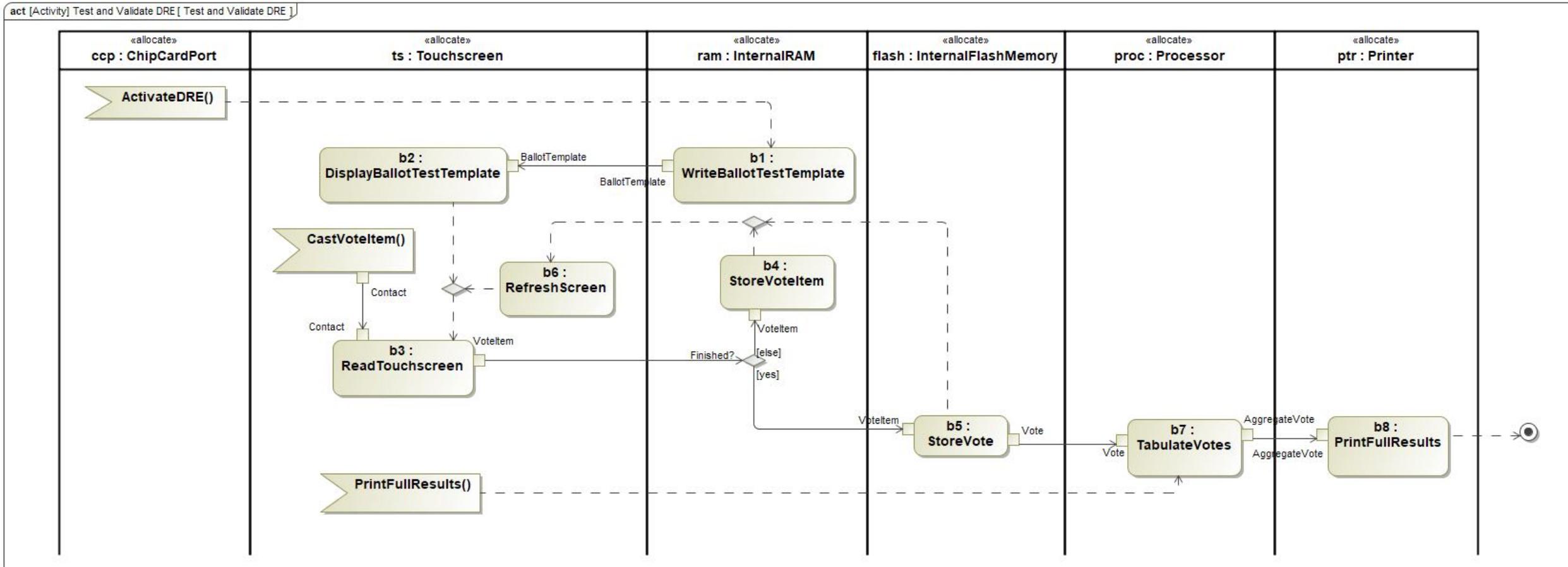
# Electronic Voting System Operations



# Electronic Voting System Software



- DRE Software functions are linked to GitHub-managed software files by Syndia



# Electronic Voting System Software



- DRE Software functions are linked to GitHub-managed software files by Syndia

The screenshot illustrates the Syndia 3.2.0 software interface, specifically the Repository Manager perspective. The interface is organized into three main panes:

- Repository:** This pane displays a hierarchical tree structure of software components. It includes sections for **VotingSystem**, **Election Domain**, **ElectronicVotingSystem** (which contains **Relations**, **CountyCentralServer**, **ElectronicVotingSystem**, and **PrecinctVotingSystem**), and **DirectRecordingElectronicSystem** (which contains **Relations**, **DirectRecordingElectricMachine**, and **DRE\_Behaviors**). The **DRE\_Behaviors** section lists various functions: **DisplayBallotTemplate**, **DisplayBallotTestTemplate**, **DisplayEndMenu**, **ExportAggregateVote**, **PrintFullResults**, **PrintVoterTotals**, **ReadBallotTemplate**, and **ReadTouchscreen**.
- Connection Type:** This pane contains four radio button options: **Reference**, **Function Wrap**, **Data Map**, and **Model Transform**. The **Model Transform** option is selected.
- GitHub @ Intercax:** This pane shows a GitHub repository structure. It includes a **GitHub @ Intercax** organization, an **InterCAX** repository, and a **User Public Repository**. The **User Public Repository** contains a **DRE\_Software** repository, which has a **Branches** folder containing a **master** branch. The **master** branch contains a **Commits** folder and a **Files** folder. The **Files** folder contains several files: **DisplayBallotTestTemplate**, **PrintFullResults**, **README.md**, **ReadTouchscreen**, **RefreshScreen**, **StoreVote**, **StoreVoteItem**, **TabulateVotes**, and **WriteBallotTestTemplate**.

A large red double-headed arrow is overlaid on the interface, pointing from the GitHub pane to the Repository pane, symbolizing the connection or mapping between the two.

The bottom status bar displays the following log messages and system status:

- [15:34:08] INFO Opening Electronic voting Specification
- [15:34:08] INFO URI: <https://intercax.jamacloud.com/perspective.req#/items/8482?projectId=47>

System status: Ready, 4:02:37 PM, 555M of 1250M.

# Electronic Voting System Software



- DRE Software functions are linked to GitHub-managed software files by Syndeia

**dazwemer / DRE\_Software**

Code Issues 0 Pull requests 0 Projects 0 Wiki Insights Settings

No description, website, or topics provided. [Edit](#)

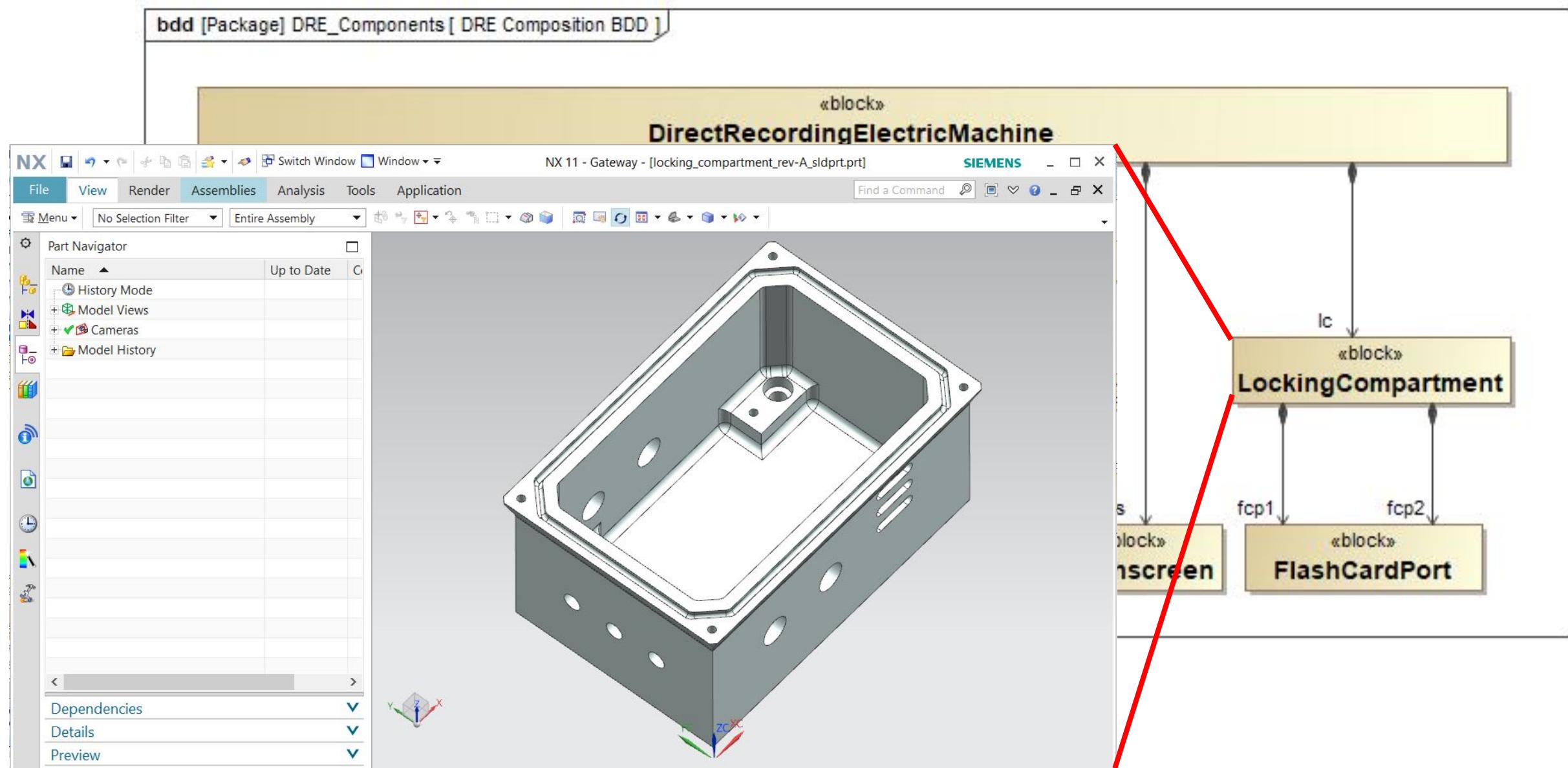
Add topics

9 commits 1 branch 0 releases 1 contributor

Branch: master New pull request Create new file Upload files Find file Clone or download

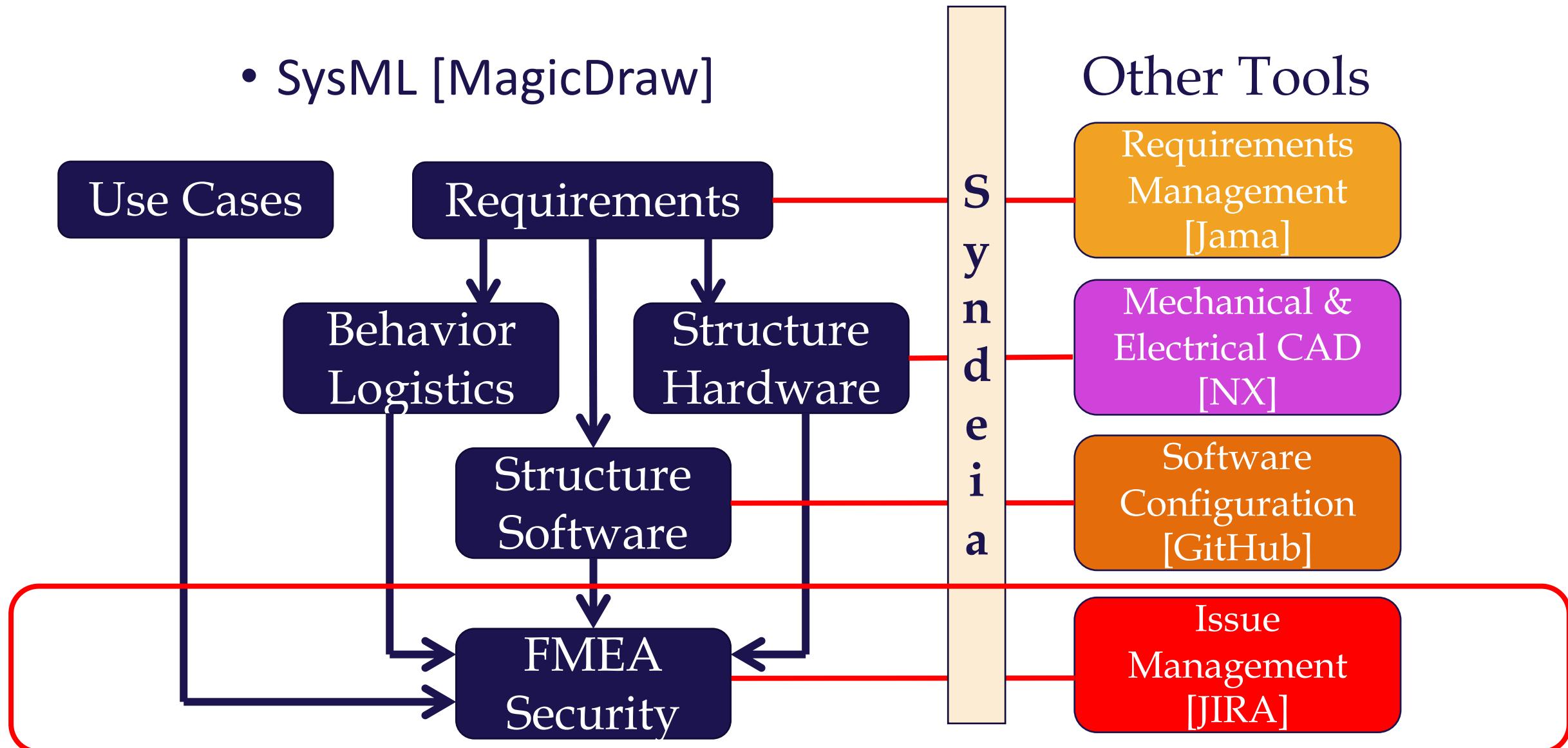
File	Commit Message	Time
PrintFullResults	Create PrintFullResults	Latest commit ad1a15c a day ago
DisplayBallotTestTemplate	Create DisplayBallotTestTemplate	a day ago
PrintFullResults	Create PrintFullResults	a day ago
README.md	Create README.md	a day ago
ReadTouchscreen	Create ReadTouchscreen	a day ago
RefreshScreen	Create RefreshScreen	a day ago
StoreVote	Create StoreVote	a day ago
StoreVoteltem	Create StoreVoteltem	a day ago
TabulateVotes	Create TabulateVotes	a day ago
WriteBallotTestTemplate	Create WriteBallotTestTemplate	a day ago

# Electronic Voting System Hardware





- SysML [MagicDraw]



# Failure Mode and Effect Analysis



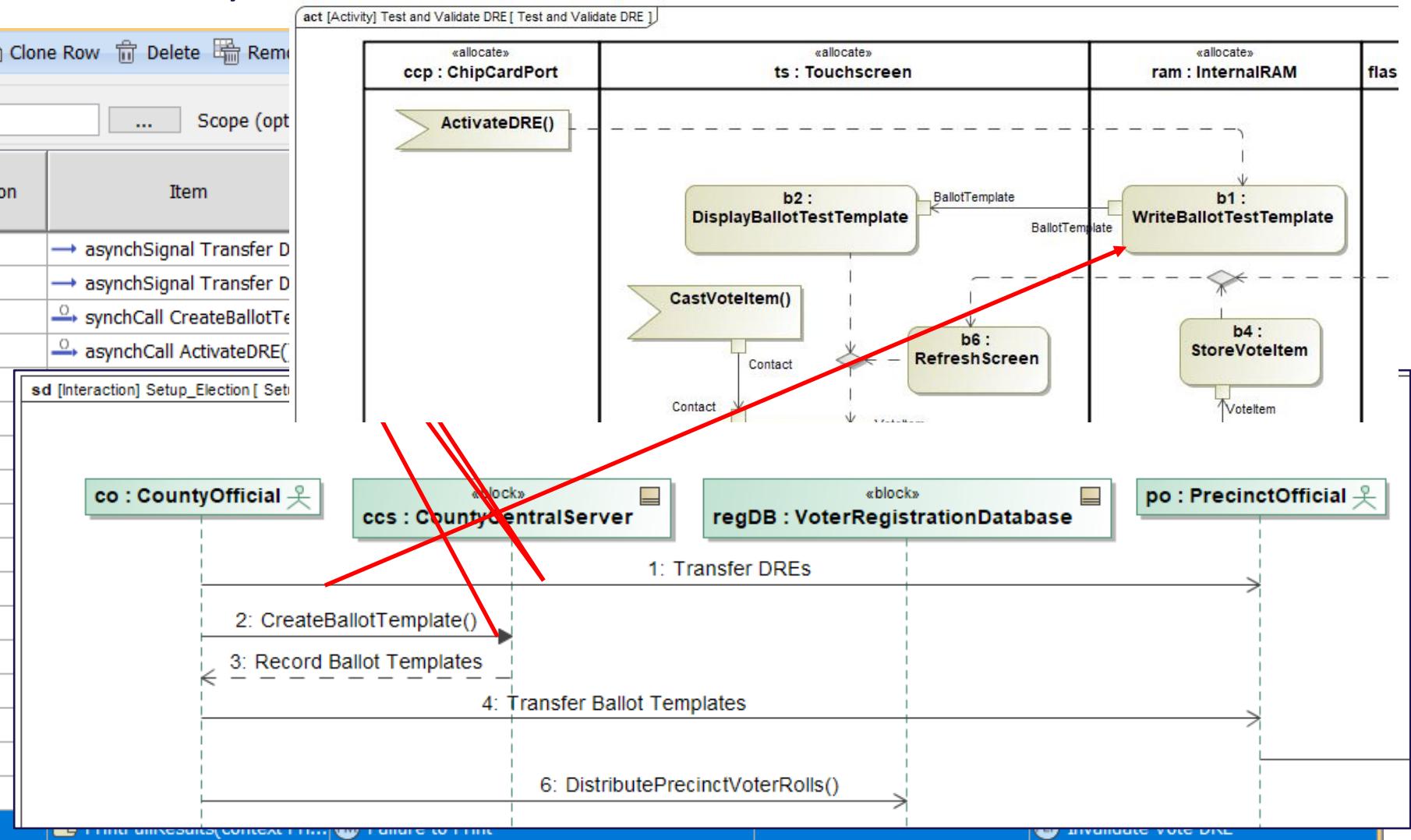
- Failure modes are identified by stepping through the behaviors and structure

Criteria

Element Type: FMEA Item

Scope (optional):

#	△ Id	Name	Classification	Item
1	F-1	(F)		→ asynchSignal Transfer D
2	F-2	(F)		→ asynchSignal Transfer D
3	F-3	(F)		○ synchCall CreateBallotTe
4	F-4	(F)		○ asynchCall ActivateDRE(
5	F-5	(F)		
6	F-6	(F)		
7	F-7	(F)		
8	F-8	(F)		
9	F-9	(F)		
10	F-10	(F)		
11	S-1	(F)		
12	S-2	(F)		
13	S-3	(F)		
14	S-4	(F)		
15	S-5	(F)		
16	S-6	(F)		
17	S-7	(F)		
18	S-8	(F)		



# Failure Mode and Effect Analysis



- Failure modes are connected to JIRA issues for tracking mitigation action

The screenshot shows a JIRA issue page for a 'Delete Vote Item' in the 'Voting Security' project. The project icon is a blue square with a white target symbol. The issue key is 'VS-17'. The page title is 'Delete Vote Item'. The top navigation bar includes 'Edit', 'Comment', 'Assign', 'To Do', 'In Progress', and 'Done' buttons. The issue details are as follows:

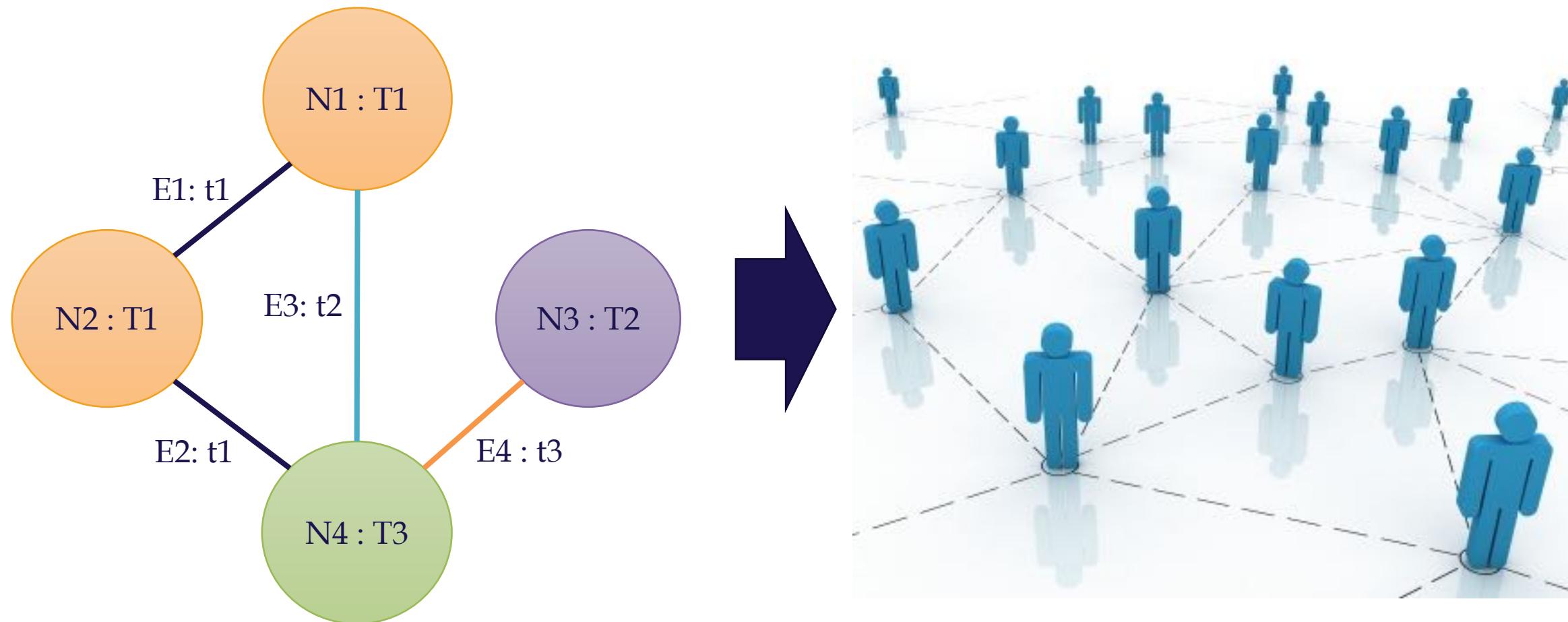
Type:	<input checked="" type="radio"/> Bug
Status:	<input type="radio"/> TO DO (View workflow)
Priority:	<input checked="" type="radio"/> Major
Resolution:	Unresolved
Labels:	None
<b>Description</b>	
<i>Click to add description</i>	
<b>Attachments</b>	
Drop files to attach, or browse.	

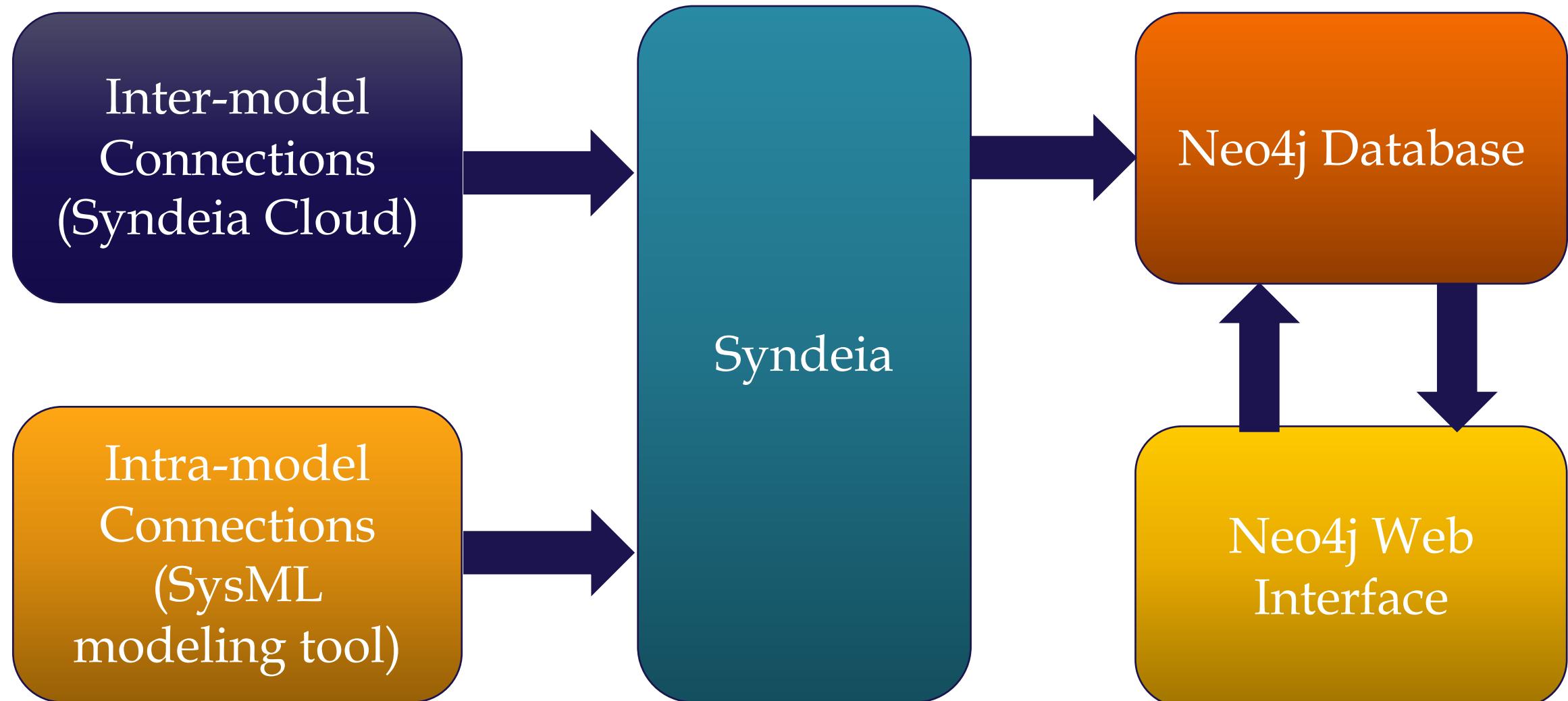
On the right side, there are additional details:

- Assignee: Dirk Zwemer (represented by a blue user icon)
- Reporter: Dirk Zwemer (represented by a blue user icon)
- Votes: 0 (represented by a blue circle with a white '0')
- Watchers: 1 (represented by a blue circle with a white '1') with a link to 'Stop watching'
- Created: 3 days ago



**Graph Theory** drives social networks like Facebook and LinkedIn  
Systems engineering needs to take advantage of the same capabilities





# Graph Queries on the Total System Model



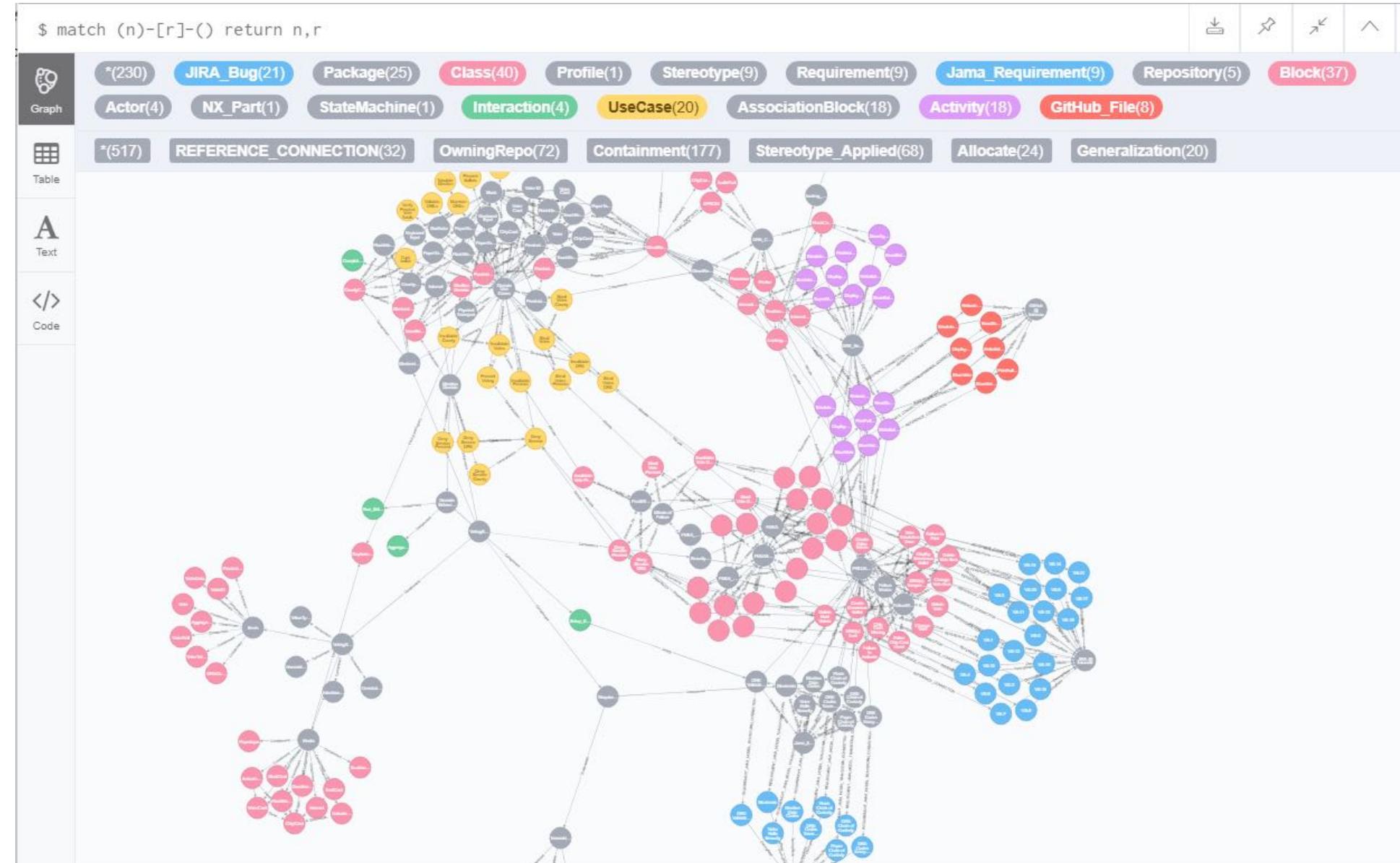
Show  
Everything

230 nodes

517 edges

Elements:

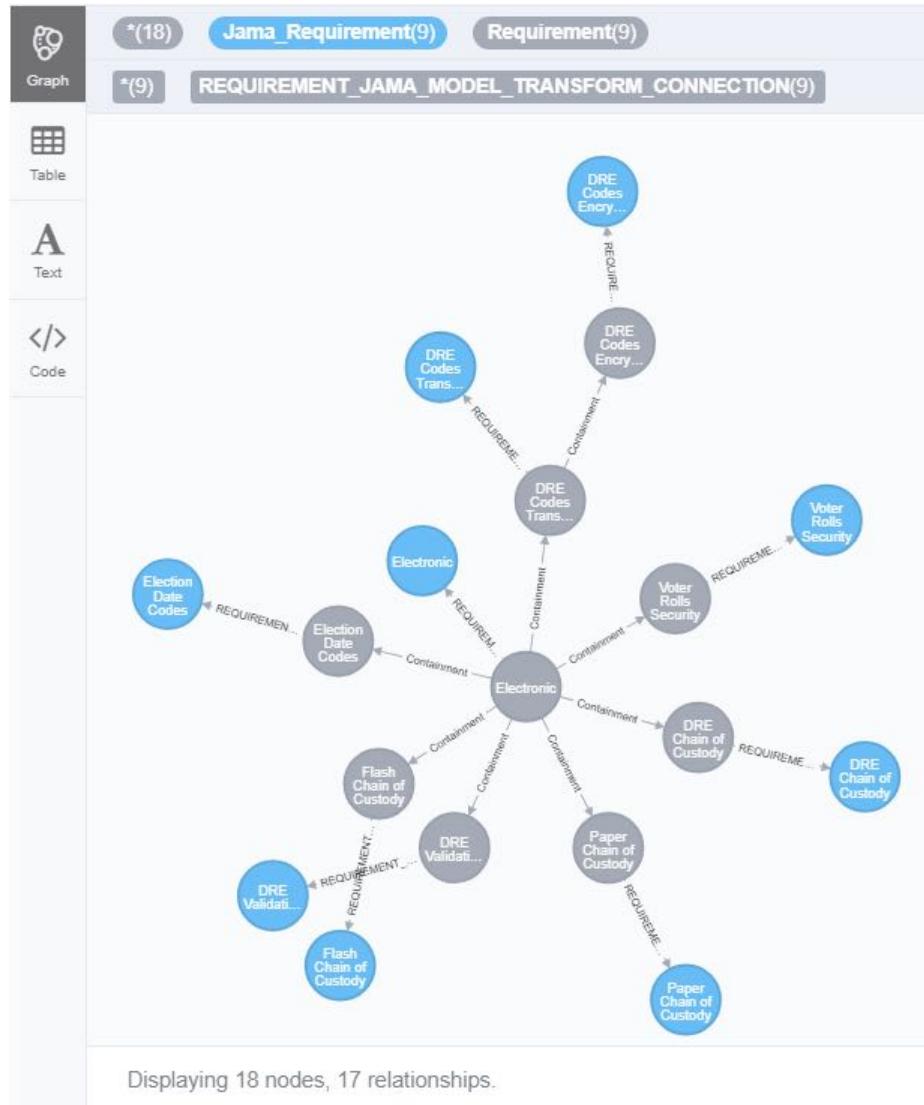
- SysML
- Jama
- JIRA
- GitHub
- NX



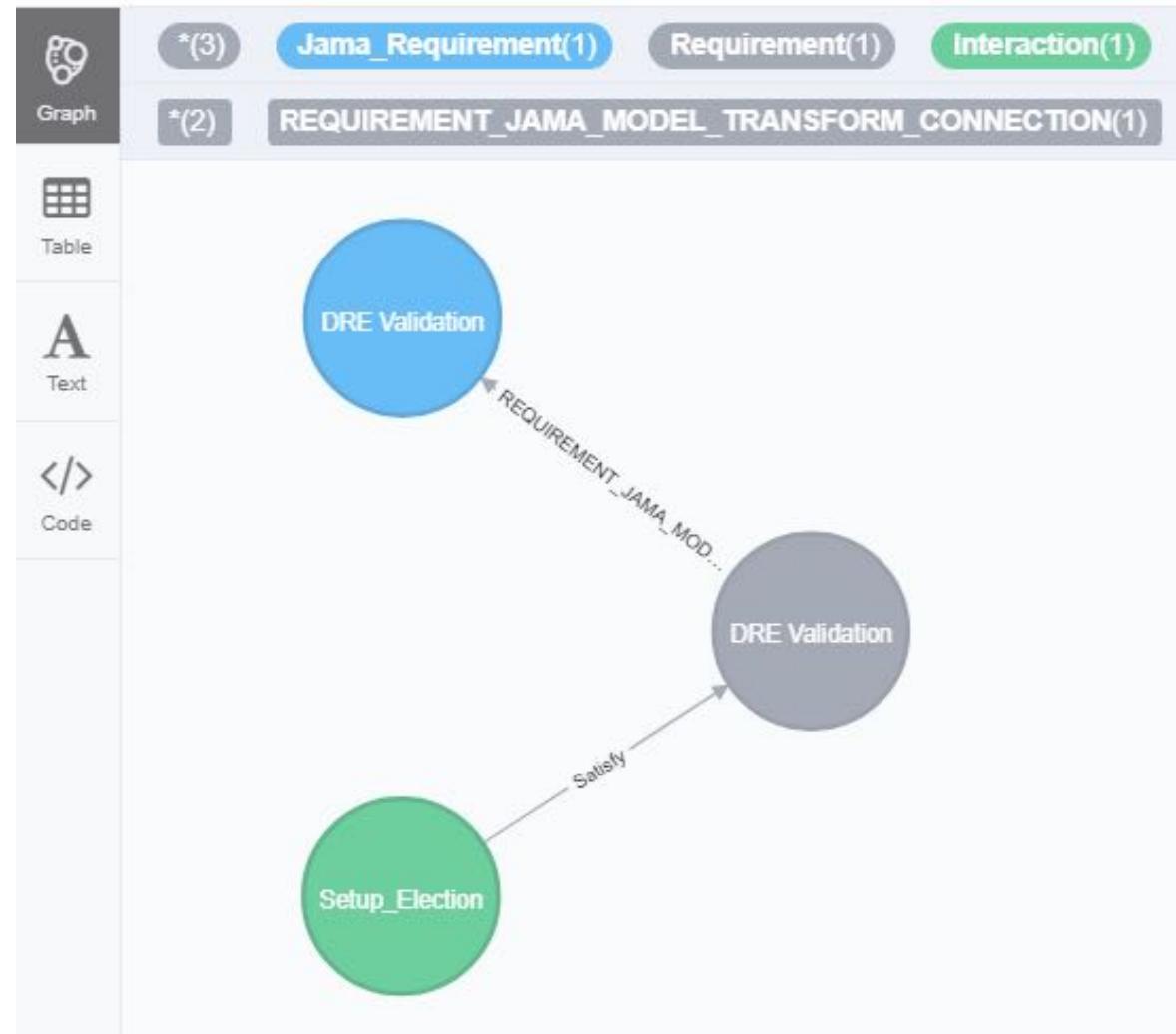
# Graph Queries on the Total System Model



Show all Jama requirements



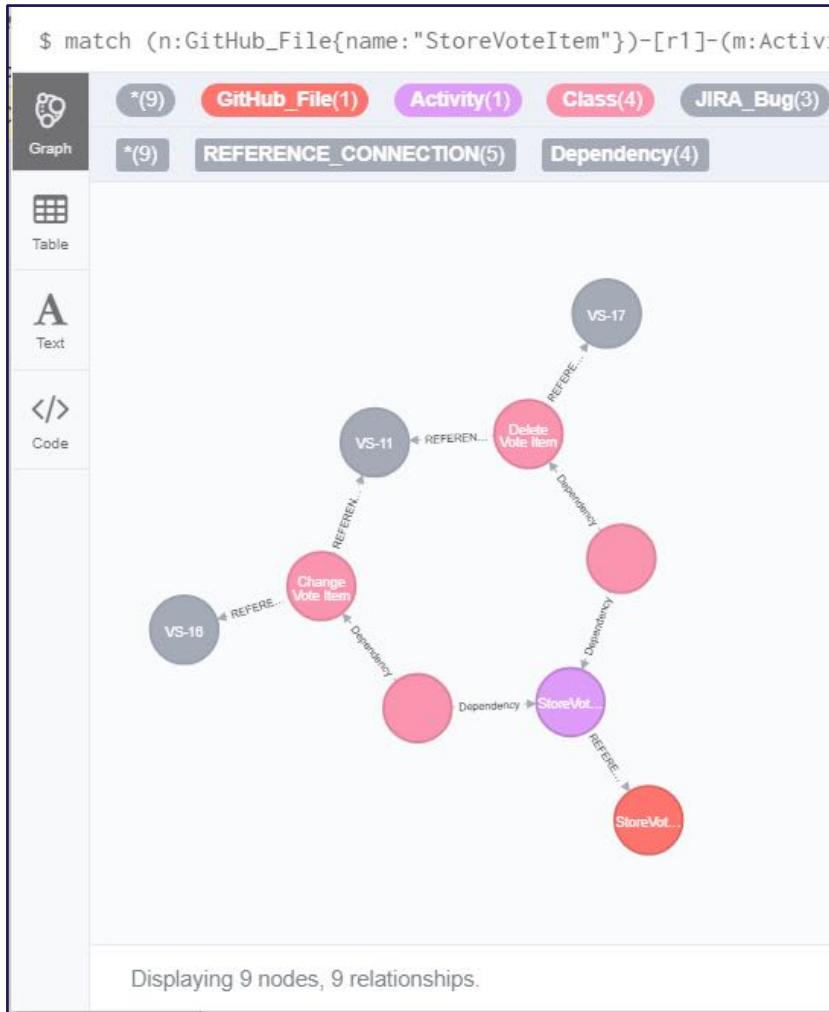
Show all “Satisfied” Jama requirements



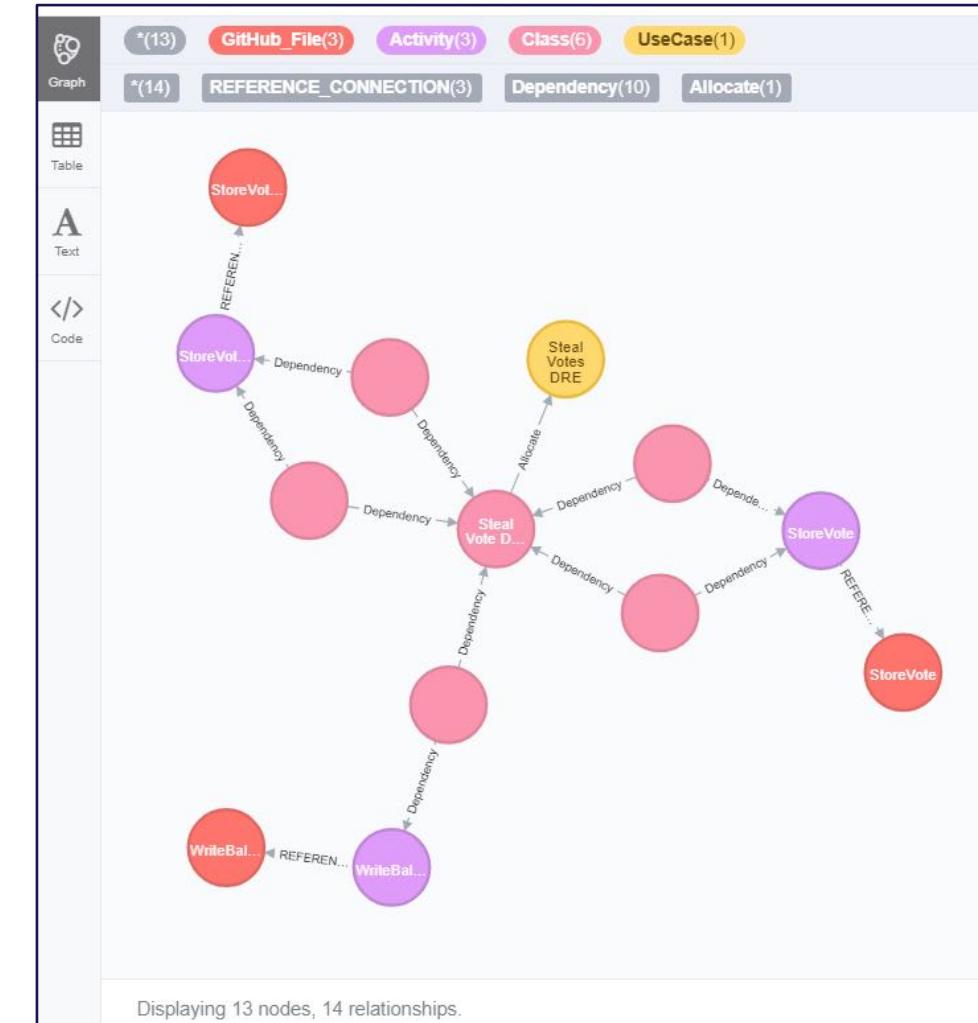
# Graph Queries on the Total System Model



Show all JIRA issues connected to GitHub file  
“StoreVoteItem”



Show all GitHub files connected to use case  
“Steal Votes DRE”





- MBSE provides a clear and self-consistent specification of EVS requirements, hardware, software, process and logistics
- MBSE allows for the systematic definition of failure modes for security analysis
- MBSE provides a framework for connecting multiple models in different software tools and building a unified roadmap of the system



- Check out our website for product info and video demonstrations at [www.intercax.com/syndeia](http://www.intercax.com/syndeia)
- Schedule a web demo with Intercax – contact us at [info@intercax.com](mailto:info@intercax.com)
- Request an evaluation license – set up an account and submit your request at [www.intercax.com/help](http://www.intercax.com/help)



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Twitter - @intercax @syndeia @manasbajaj



## Appendix



- Born: Georgia Tech spin-off 2008
- Location: Perimeter Center, Atlanta; Pune IT Park, Pune, India
- Focus: Software for MBSE
  - **Syndeia** - PLM/CAD/CAE/ALM Integration with SysML
  - SysML parametric solvers (**ParaMagic**, **Melody**, **ParaSolver**, **Solvea**)
- Training and Custom Development
  - 4000+ students since 2008
- Customers
  - Aerospace, Automotive, Defense, others



- Syndeia can enhance communication between departments, navigate across system data for design reviews, and support failure and safety analysis.
  - Have any requirements impacting my design changed since time A?
  - Where is the test data for design variant B?
  - What was the total product configuration on date C?



# Electronic Voting System Operations

