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TCL:
Train Signaling with Automatic Code Generation

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Overview

- Railway Interlocking System
- Current Development Process
- Train Control Language (TCL)
- Safety Issues
- Variability Modeling
- Conclusion

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Railway Interlocking System

- Prevent conflicting and dangerous train movements
- Computer based interlocking (CBI)
  - Source code created for every station
- Based on Programmable Logic Controller (PLC)
- Two PLCs with diversified code to enhance safety

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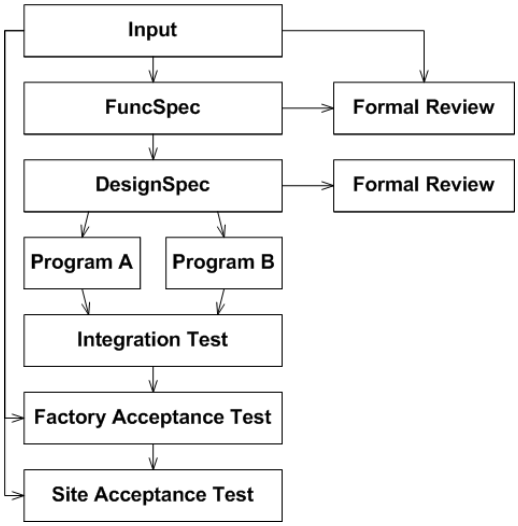
Current Development Process



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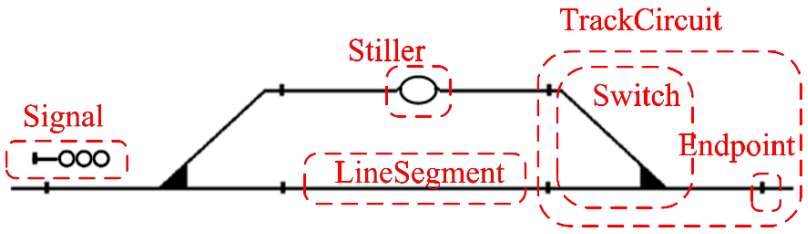
TCL – Concrete Syntax



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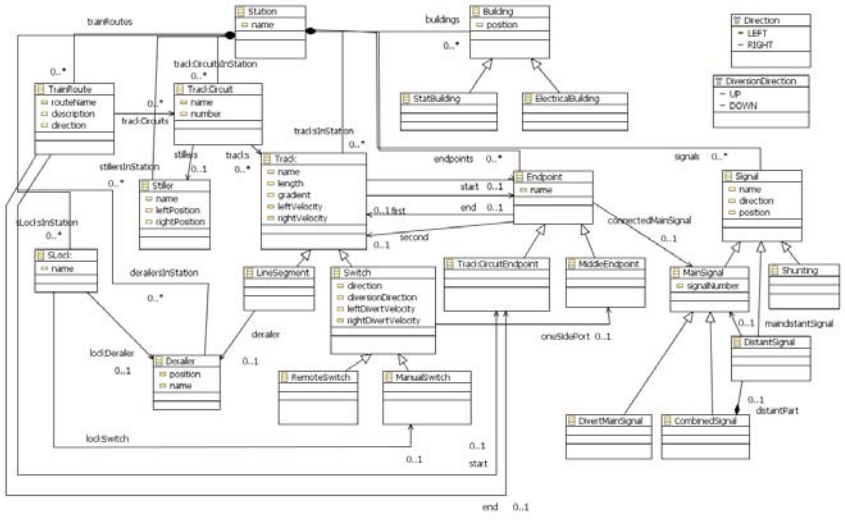
TCL - Metamodel



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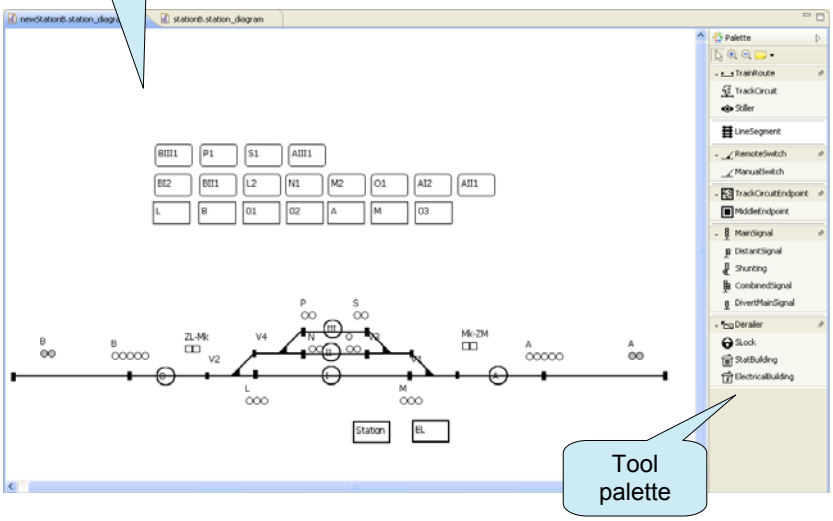
TCL – Graphical Editor

Station model



Tool palette

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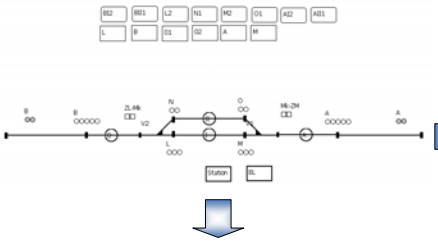
TCL – Tools



```
Str_br_1(Hj_Str_br:=Felles.Hj_Str_br,
Sf_n1_F := Sf_A.Fk,
Sf_n2_F := Sf_B.Fk,
TP := TID.tStr_br,
Str_br => Felles.Str_br);
```

Train Route Description	Train Route	Stiller B L/N	B	Stiller A A	M/O	Stiller II A/N	B/O	Stiller I A/L	B/M	Switch V2	Switch V1	Train Routes BI2	BII1	L2	N1	M2	O1	AI2	AII1	Track Circuits L	B	01	02	A	M
From StationA to Track 1	BI2	-						-		+		-	+	+		+	+	+		=		=		=	
From StationA to Track 2	BII1	-				-				-		+	-	+	+	+		+		=		=		=	
From Track 1 to StationA	L2	-						-		+		+	+	-	+				+	=		=			
From Track 2 to StationA	N1	-				-				-		+	+	+	-			+		=		=			
From Track 1 to StationC	M2			-					-		+		+			-	+	+				=		=	
From Track 2 to StationC	O1			-		-					-	+				+	-	+				=		=	
From StationC to Track 1	AI2			-				-			+	+	+		+	+	+	-	+	=		=			
From StationC to Track 2	AII1			-		-					-	+	+	+		+	+	+	-	=		=		=	

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Ensuring Completeness and Consistency

- **Representations generated from a common model**
  - Consistency between the representations can be guaranteed
- **Constraints on the editor guarantees completeness**
  - By not omitting any necessary elements
- **Still need to validate and test the results**
  - To ensure a completely safe system

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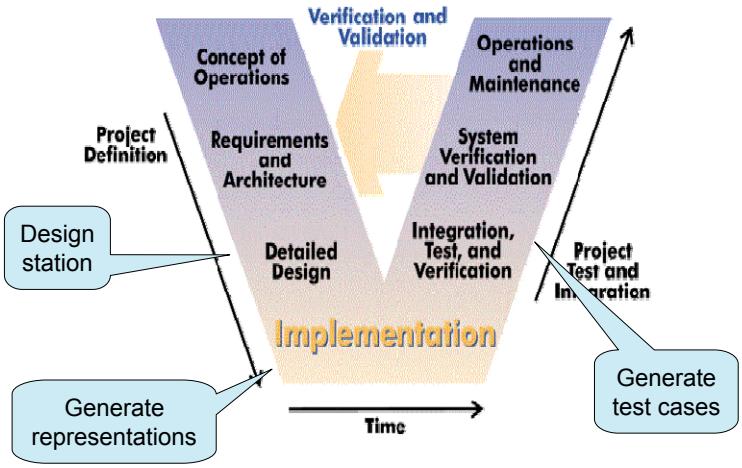
TCL - Safety Integration



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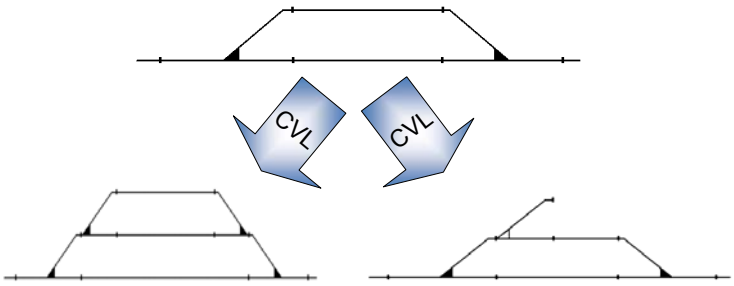
Variability Modeling



Can it be proven that these new stations are correct and safe?

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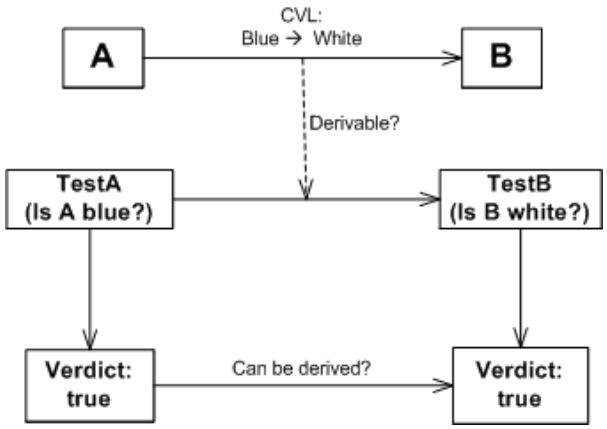
Variability Modeling (2)



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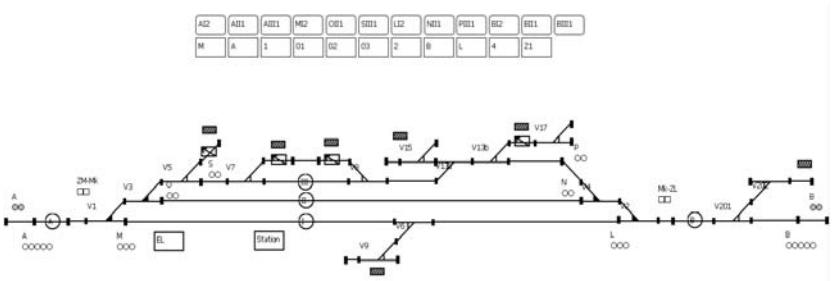
Station M



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Conclusion

- **A DSL can improve the development process of interlocking systems**
- **Representations directly generated from the graphical model:**
  - Interlocking table, source code, tests, etc.
- **Assures consistency and completeness**
- **Comprehensive validation of the code generators is needed**
- **The approach has definite potentials**