

A Model-Driven Approach for Managing Dynamic Variability



INFORMATION TECHNOLOGY FOR EUROPEAN ADVANCEMENT

Franck Fleurey

SINTEF

franck.fleurey@sintef.no



- Largest independent research organisation in Scandinavia

- About 2000 employees
 - 1200 in Trondheim
 - 800 in Oslo

- 7 Divisions
 - ICT about 280 researchers

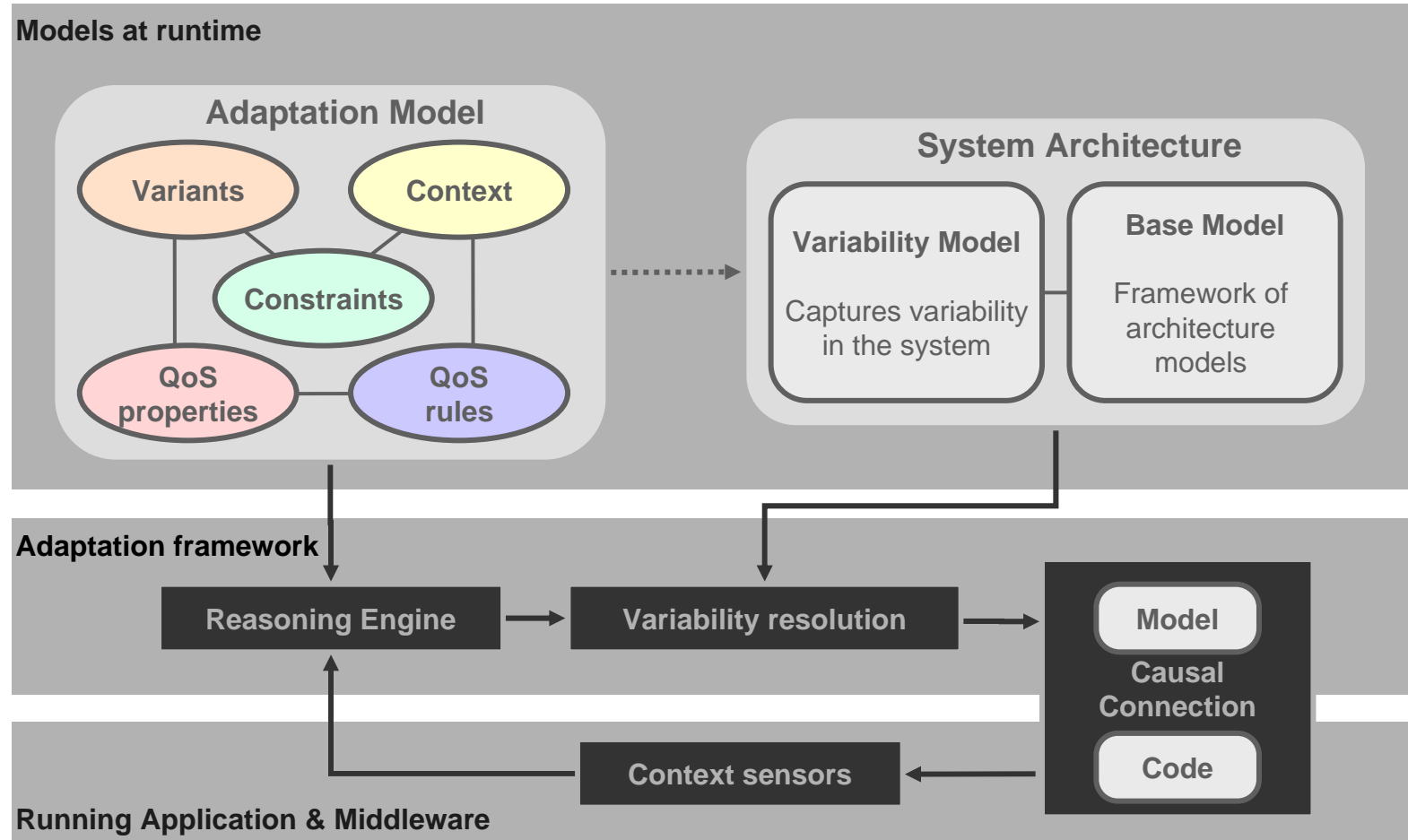
- Runtime variability / Adaptive applications
 - Need to change architecture and behavior at runtime
 - Flood prediction network of sensors
 - Crisis management system
 - etc

- Current practices have limitations
 - Reflection
 - Reconfiguration scripts
 - etc

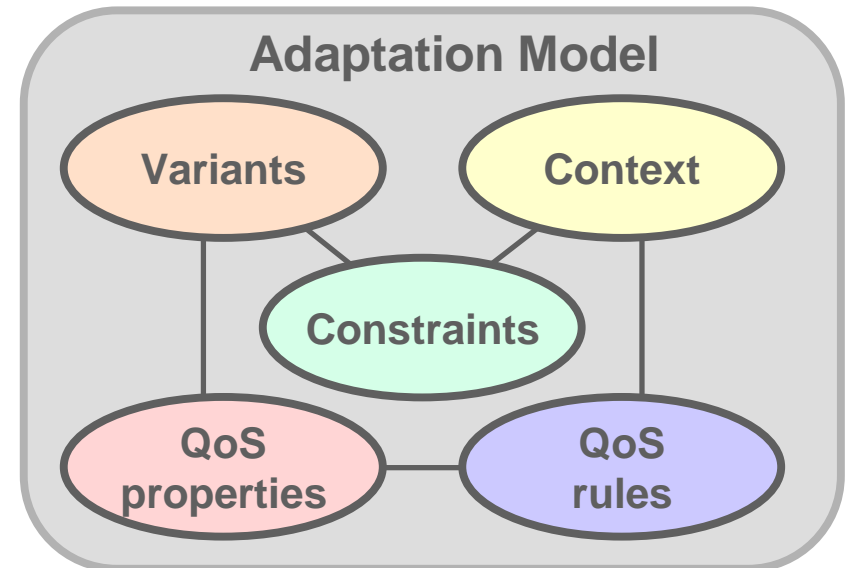
- Objectives
 - Handle dynamic variability early
 - Generate the adaptation logic

- Overview of the approach
- Modeling adaptation
- Example: Flood prediction sensors
- Simulation of adaptation
- Discussion & perspectives

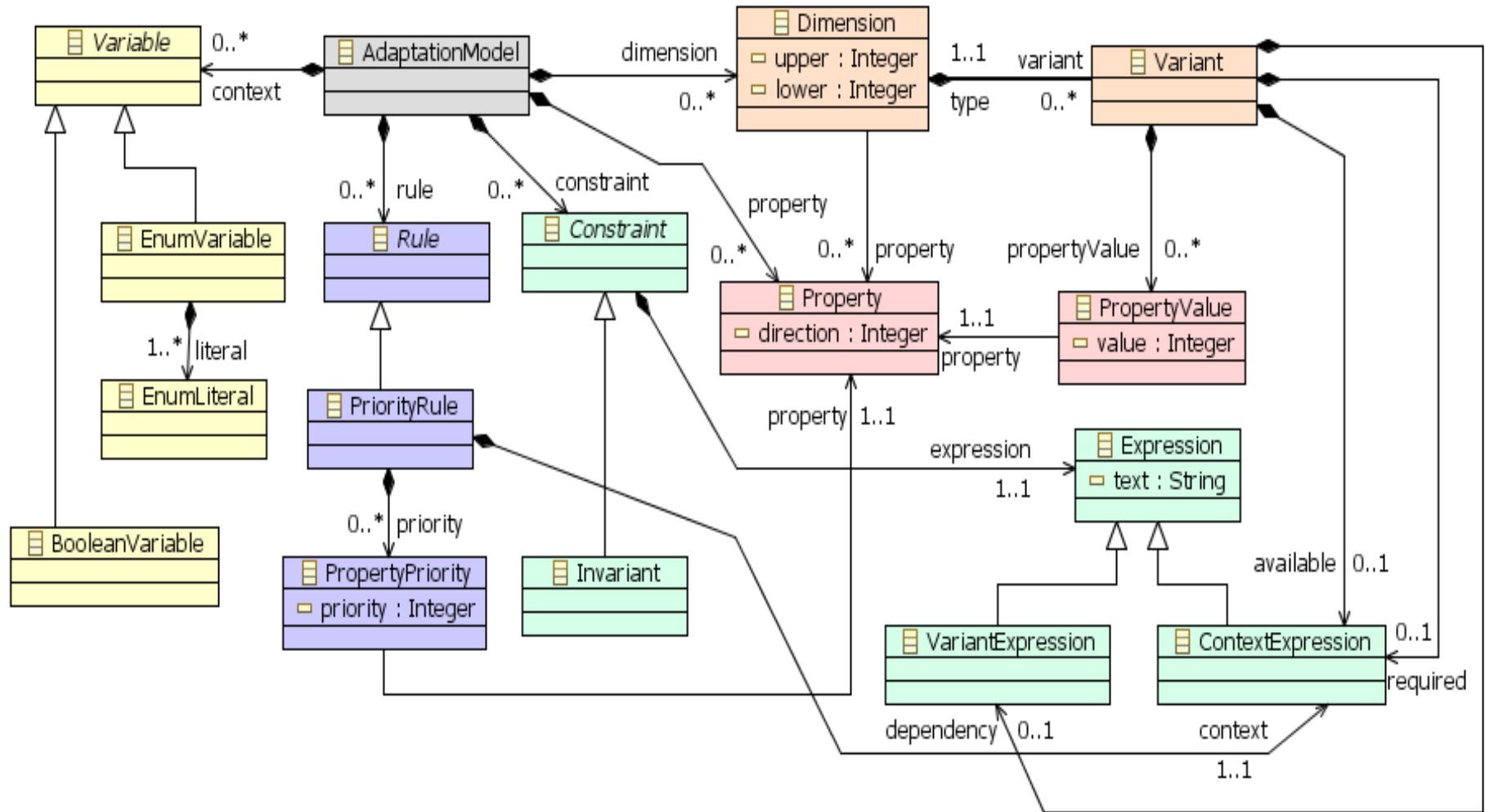
Overview of the approach

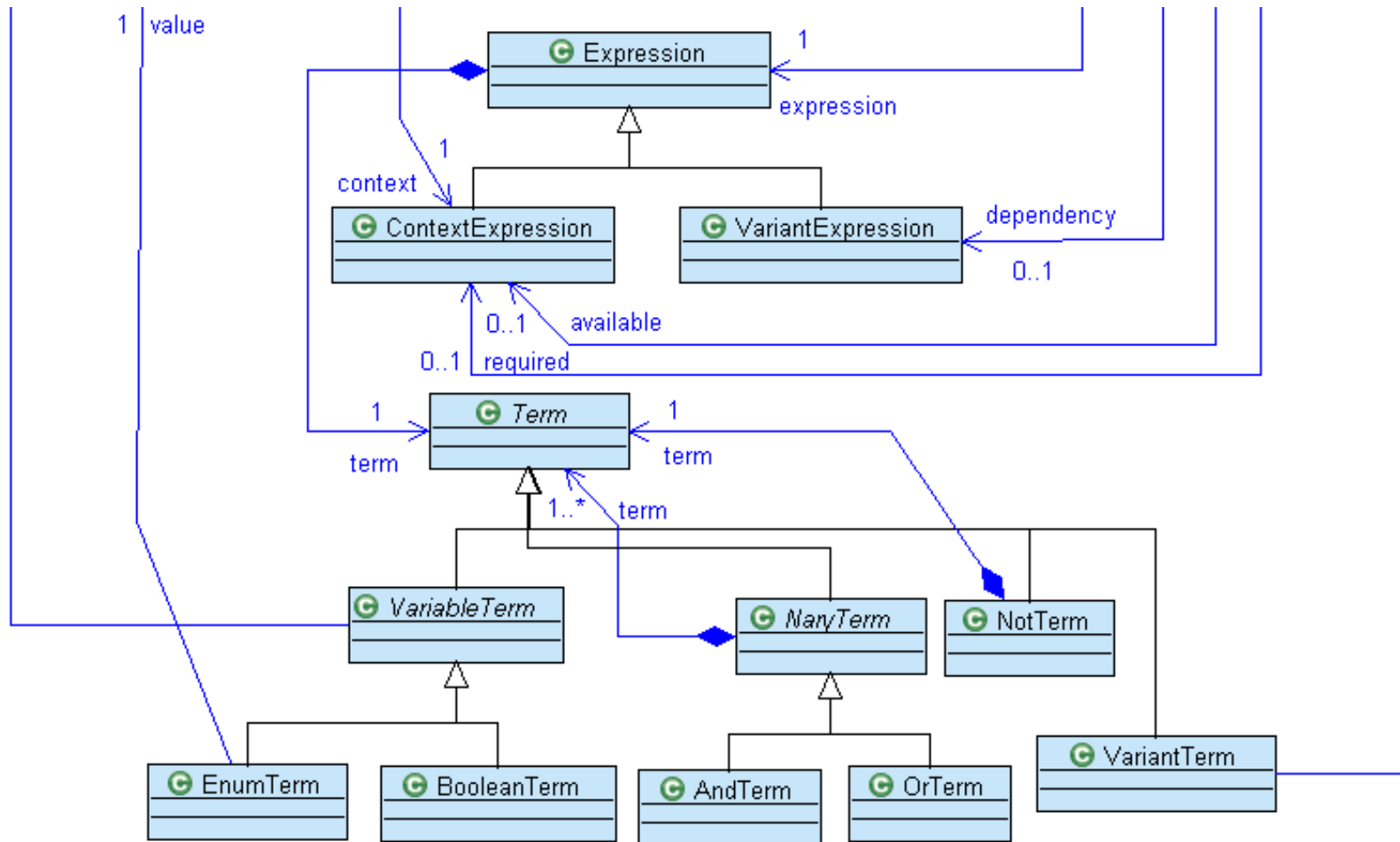


- Variability in the system
- Dependencies
- Variability in the environment
- Constraints
- Adaptation policies
















Adaptation meta-model


























- Flood prediction application
 - Distributed network of sensors
 - Measure river parameters (Water level, Flow, ...)
 - Exchange data via Bluetooth or WIFI
 - Send data to a central server via GPRS
 - Can carry local flood predictions
 - Power by batteries and solar panel
 - ...






		Name	ID	Lower	Upper	
[-]		Dimension	Routing	RTG	1	1
		Variant	Shortest Path	SP	-	-
		Variant	Fewest Hops	FH	-	-
[-]		Dimension	Networking	NET	1	-1
		Variant	Bluetooth	BT	-	-
		Variant	Wifi	WIFI	-	-
		Variant	GPRS	GPRS	-	-
[-]		Dimension	Camera	CAM	1	1
		Variant	Single Camera	SC	-	-
		Variant	Multiple Camera	MC	-	-
[-]		Dimension	Fuctionality	FUNC	0	-1
		Variant	Local Prediction	LP	-	-
		Variant	Gateway	GW	-	-














		Name	ID	Values
	Enum	Current Situation	Situation	{N, P, F}
	Literal	Normal	N	-
	Literal	Flood Predicted	P	-
	Literal	Flood	F	-
	Boolean	WIFI Signal Available	WFSig	-
	Boolean	Bluetooth Signal Available	BTSig	-
	Boolean	Elected Gateway	ElectGW	-
	Boolean	Low Battery	LowBatt	-






Constraints

	Name	ID	Lower	Upper	Dependency	Available	Required
[-] 	Dimension	Routing	RTG	1	1	-	-
	Variant	Shortest Path	SP	-	-		
	Variant	Fewest Hops	FH	-	-		
[-] 	Dimension	Networking	NET	1	-1	-	-
	Variant	Bluetooth	BT	-	-	not WIFI	BTSig
	Variant	Wifi	WIFI	-	-	not BT	WFSig
	Variant	GPRS	GPRS	-	-		ElectGW or not WFSig or BTSig
[-] 	Dimension	Camera	CAM	1	1	-	-
	Variant	Single Camera	SC	-	-		Situation = N
	Variant	Multiple Camera	MC	-	-		
[-] 	Dimension	Fuctionality	FUNC	0	-1	-	-
	Variant	Local Prediction	LP	-	-		not LowBatt
	Variant	Gateway	GW	-	-	GPRS	ElectGW

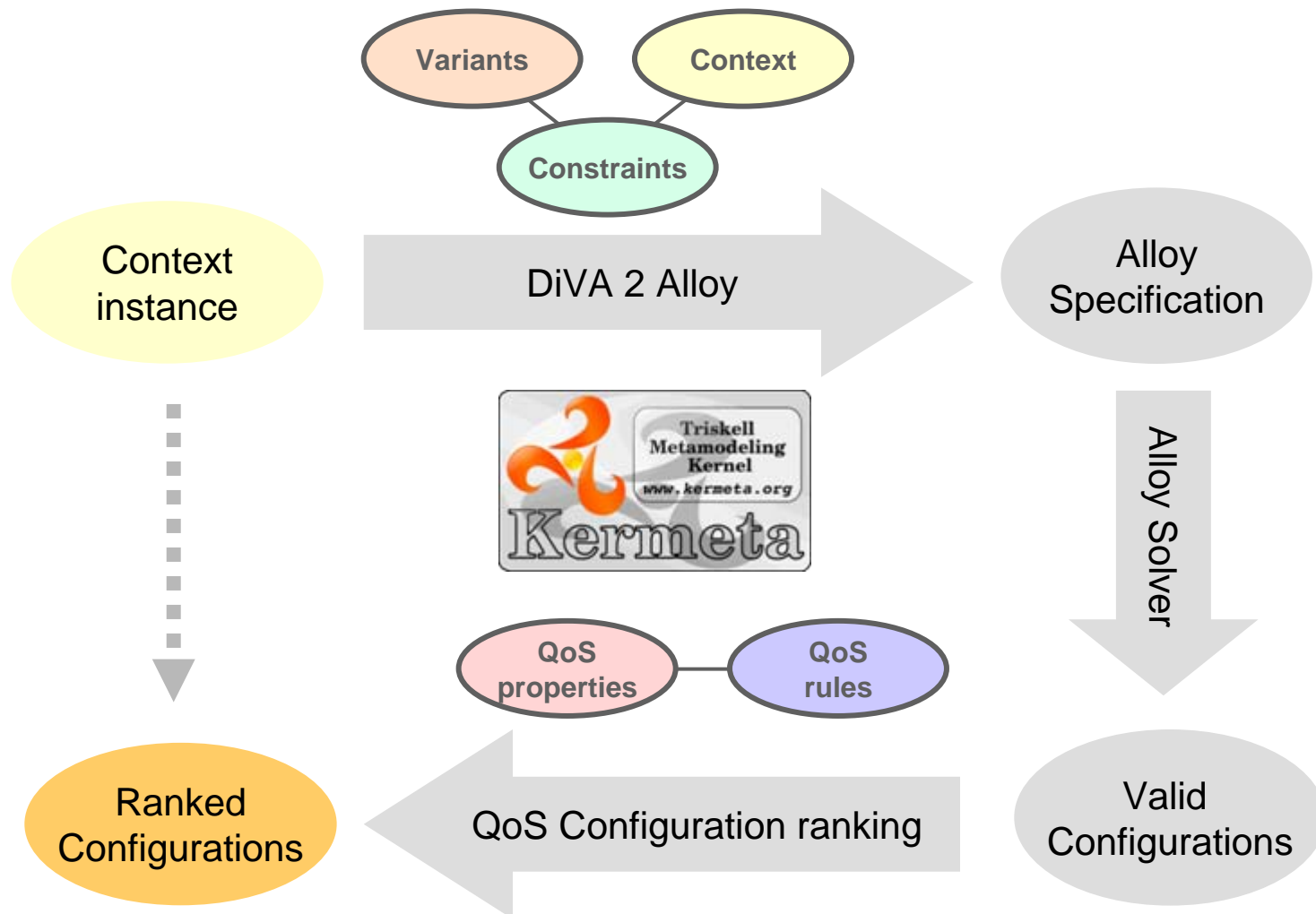
Properties and impacts

	Name	ID	Direction
	Property	Power Consumption	PWR
	Property	Mesurment Accuracy	ACC
	Property	Node Fault Tolerance	FT

	Power Consumption	Mesurment Accuracy	Node Fault Tolerance
<input type="checkbox"/>  Routing (RTG)	true	false	true
 Shortest Path (SP)	Low	-	Low
 Fewest Hops (FH)	High	-	High
<input type="checkbox"/>  Networking (NET)	true	false	false
 Bluetooth (BT)	Low	-	-
 Wifi (WIFI)	High	-	-
 GPRS (GPRS)	Medium	-	-
<input type="checkbox"/>  Camera (CAM)	true	true	false
 Single Camera (SC)	Low	Low	-
 Multiple Camera (MC)	High	High	-
<input type="checkbox"/>  Fuctionality (FUNC)	true	false	false
 Local Prediction (LP)	High	-	-
 Gateway (GW)	Medium	-	-

	Name	ID	Guard	Power Consumption	Mesurment Accuracy	Node Fault Tolerance
 Rule	Normal Mode	NM	Situation = N	Medium	Medium	Low
 Rule	Flood Predicted Mode	PM	Situation = P	N/A	High	Low
 Rule	Flood Mode	FM	Situation = F	N/A	High	High
 Rule	Battery is Low	LB	LowBatt	High	N/A	N/A
 Rule	Battery is OK	LB	not LowBatt	Low	N/A	N/A

- Choose a configuration from the context
 - All valid configurations configuration
 - Combine variants for each dimension
 - Build all combination between dimensions
 - Filter based on dependencies
 - Valid configurations for a specific context
 - Filter based on available variants
 - Filter based on required variants
 - Ranking configuration
 - Evaluate property rules
 - Compute properties values for each configuration
 - Compute a score for each configuration
 - Choose a configuration
 - Best score



- Total number of configuration: 112
 - Combinations of variants according to multiplicities
- Number of valid configuration: 64
 - After applying constraints
- Total number of contexts: 48
 - All combinations of the context variables
- Example simulation:
 - For context:
 - Situation=N and WFSig
 - 4 Valid configurations:
 - SC FH WIFI LP (Score = 0)
 - SC SP WIFI LP (Score = 2)
 - SC FH WIFI (Score = 12)
 - SC SP WIFI (Score = 14)

- CONTEXT : Situation=P WFSig
 - LP SC SP WIFI (Score = -6)
 - FH LP SC WIFI (Score = -6)
 - LP MC SP WIFI (Score = -2)
 - FH LP MC WIFI (Score = -2)
 - SC SP WIFI (Score = 2)
 - FH SC WIFI (Score = 2)
 - MC SP WIFI (Score = 6)
 - FH MC WIFI (Score = 6)

- CONTEXT : Situation=F WFSig
 - LP SC SP WIFI (Score = 4)
 - LP MC SP WIFI (Score = 8)
 - FH LP SC WIFI (Score = 8)
 - SC SP WIFI (Score = 12)
 - FH LP MC WIFI (Score = 12)
 - MC SP WIFI (Score = 16)
 - FH SC WIFI (Score = 16)
 - FH MC WIFI (Score = 20)

- Tool for adaptation modeling and simulation
- 2 industrial case studies (DiVA)

- Size of first industrial scenario
 - 15 context variables
 - About 100 000 contexts
 - 7 variability dimensions
 - 19 variants
 - More that 500 000 configurations
 - 4 QoS properties
 - 7 Priority rules

- Adaptation meta-model
 - Modeling of variants
 - Dimensions ? feature models ?
 - Connection with variability model
 - Context variables
 - Structure ? Types ?
 - Rules
 - Types of rules ?
 - Semantics
 - Efficient algorithm
- Simulation
 - Model checking
 - Partial simulation
 - variability dimension, depth, variables, ...
 - Adaptation model testing

Thank you for your attention !

