

“RM-ODP part 2: Foundations” in Alloy

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This paper presents the Alloy ([3], [4], [5]) code for the formalization of “RM-ODP part 2: Foundations” [1]. The formalization is defined and explained in the separate work [6], [7].

```
/* ----- beginning of code ----- */

model RM-ODP {
  domain {ODP_Concepts}
  state {

/* declaration of ODP concept categories (RM-ODP 2.5) */

    partition BasicInterpretationConcepts, BasicModellingConcepts, SpecificationConcepts : static ODP_Concepts

/* declaration of "Basic interpretation concepts" (RM-ODP 2.6) */

    partition UniverseOfDiscourse, InterpretationPossibilities : static BasicInterpretationConcepts
    partition Entity, Proposition: UniverseOfDiscourse
    partition FirstOrderProposition, HigherOrderProposition: Proposition
    holds : Proposition -> UniverseOfDiscourse+
    System : Entity
    Sybssystem : System

/* introduction of relations between RM-ODP concept categories */

    modeledByBMC : FirstOrderProposition -> BasicModellingConcepts
    modeledBySC : HigherOrderProposition -> SpecificationConcepts
    mappedToBMC : SpecificationConcepts -> BasicModellingConcepts
    mappedToSC : BasicModellingConcepts -> SpecificationConcepts

/* declaration of "Basic modelling concepts" (RM-ODP 2.8) */

    partition Constitution, SpaceTime, Information : static BasicModellingConcepts
    partition Object, Environment : static Constitution
    environment (~object) : Object! -> Environment!
    partition StructuralInfo, BehaviorallInfo : static Information
    Behavior : BehaviorallInfo
    State_ : StructuralInfo
    partition Action, BehavioralConstraint: static Behavior
    corresponding_constraint (~constrained_action) : Action -> BehavioralConstraint
    partition InternalAction, Interaction : static Action
    partition InteractionPoint, Space, Time : static SpaceTime
    Interface: Behavior
    Activity: Behavior
    LocationInSpace : Space
    space_within_interval : LocationInSpace -> Space+
    state_location(~corresponding_state) : State_! -> Space! /* introduced to link Information and Space for the defini-
tion of LocationInSpace */
    LocationInTime : Time
    time_within_interval : LocationInTime -> Time+
    interface_at_interaction_point: InteractionPoint -> Interface
    space_location: InteractionPoint -> LocationInSpace!
    time_location: InteractionPoint -> LocationInTime!
    constitution_state: Constitution! -> State_
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object_state: Object! -> State_
environment_state: Environment! -> State_
potential_activity: State_ -> Activity+
object_behavior: Object! -> Behavior!
environment_behavior: Environment! -> Behavior!
instant: Time -> Time!
state_existence: Time! -> State_!
constraining : Environment! -> BehavioralConstraint
participant : Action -> Constitution
participating_object : Action -> Object!
instant_begin : Action -> Time!
instant_end : Action -> Time!
X : BasicModellingConcepts

/* declaration of "Specification concepts" (RM-ODP 2.9) */

partition Type, Class, Instance, Composition, Decomposition: SpecificationConcepts
TemplateType: Type
Template, InstantiationRules : TemplateType
Instantiation: Instance
partition Creation, Introduction : Instantiation
associated_type: Class! -> Type!
member_of_class(~set_of): Instance+ -> Class!
satisfies_type(~valid_for): Instance+ -> Type!
TemplateClass: Class
associated_template_type: TemplateClass! -> TemplateType!
member_of_template_class(~set_of_instantiations): Instantiation+ -> TemplateClass!
subtype(~supertype): Type -> Type
subclass(~superclass): Class -> Class
specification (~instantiation): Instantiation -> Template!
derived_class(~base_class): TemplateClass -> TemplateClass
incremental_modification: Template -> Template
refinement: SpecificationConcepts -> SpecificationConcepts

/* declaration of "Specific Specification concepts" (RM-ODP 2.9) */

Role, Invariant, Precondition, Postcondition : Type
composite_object: Decomposition -> Object!
interface_signature: Template -> Interface!
}

/* invariant for "Basic interpretation concepts" (RM-ODP 2.6) */

inv AssertOrDeny {
  all a: UniverseOfDiscourse, b: Proposition | (a in b.holds) || (a not in b.holds)
}

/* invariant for "Basic modelling concepts" (RM-ODP 2.8) */

inv TimeDependance{
  all o: Object, t: Time | one t.instant ->one o.object_state
}

/* definitions for "Basic interpretation concepts" (RM-ODP 2.6) */

def FirstOrderProposition {
  all p: FirstOrderProposition | (p.holds: Entity)
}
def HigherOrderProposition {
  all p: HigherOrderProposition | (p.holds: Proposition)
}

/* definitions for relations between RM-ODP concept categories */

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def mappedToBMC {
  all bmc: BasicModellingConcepts, sc: SpecificationConcepts, fop: FirstOrderProposition, hop: HigherOrder-
Proposition | bmc in sc.mappedToBMC <-> (fop.holds=hop.holds.holds) && (fop.modeledByBMC = bmc) &&
(hop.modeledBySC = sc)
}
def mappedToSC {
  all bmc: BasicModellingConcepts, sc: SpecificationConcepts, fop: FirstOrderProposition, hop: HigherOrder-
Proposition | sc in bmc.mappedToSC <-> (fop.holds=hop.holds.holds) && (fop.modeledByBMC = bmc) &&
(hop.modeledBySC = sc)
}

/* definitions for "Basic modelling concepts" (RM-ODP 2.8) */

def participant {
  all a: Action, b: Constitution | b in a.participant <-> (a.instant_begin.state_existence in b.constitution_state)
&& (a.instant_end.state_existence in b.constitution_state) /*pre & post state are in the allowed states of the content;
introduced to characterize those entity models, which participate in an Action - to define Action associated with an
object, Internal Action and Interaction */
}
def Action{
  all a: Action | (a.instant_begin != a.instant_end) && (a.instant_begin.state_existence !=
a.instant_end.state_existence) && (a.participating_object in a.participant) /* the last condition is here to show that
there exist at least one object associated with an action*/
}
def InternalAction {
  all a: InternalAction | a.participating_object in a.participant -> a.participating_object.environment not in
a.participant
}
def Interaction {
  all a: Interaction | a.participating_object in a.participant -> a.participating_object.environment in a.participant
}
def Behavior {
  all b: Behavior | ((b in Action) && ( some b.corresponding_constraint) && ( b.corresponding_constraint in
Behavior)) || ((b in BehavioralConstraint) && ( some b.constrained_action) && ( b.constrained_action in Behavior))
}
def Interface {
  all i: Interface | ((i in Interaction) && ( some i.corresponding_constraint) && ( i.corresponding_constraint in
Interface)) || ((i in BehavioralConstraint) && ( some i.constrained_action) && ( i.constrained_action in Interface))
}
def LocationInSpace {
  all ls: LocationInSpace | some a | (a.instant_begin.state_existence.state_location in
ls.space_within_interval) && (a.instant_end.state_existence.state_location in ls.space_within_interval)
}
def LocationInTime {
  all lt: LocationInTime | some a | (a.instant_begin in lt.time_within_interval) && (a.instant_end in
lt.time_within_interval)
}
def interface_at_interaction_point {
  all ip: InteractionPoint, i: Interface | (i in ip.interface_at_interaction_point) <->
((i.instant_begin.state_existence.state_location in ip.space_location.space_within_interval) &&
(i.instant_end.state_existence.state_location in ip.space_location.space_within_interval) && (i.instant_begin in
ip.time_location.time_within_interval) && (i.instant_end in ip.time_location.time_within_interval))
}
def InteractionPoint {
  all ip: InteractionPoint | one ls: LocationInSpace | one lt: LocationInTime | ip.space_location = ls &&
ip.time_location = lt && some ip.interface_at_interaction_point
}
def X {
  all a: X | a.mappedToSC.mappedToBMC = a
}

/* definitions for "Specification concepts" (RM-ODP 2.9) */

def Class {

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        all c: Class | some i | one t | i.satisfies_type = t && i in c.set_of && i.member_of_class = c &&
c.associated_type = t
    }
def Instance {
    all a: Instance | some t | a.satisfies_type = t
}
def subtype {
    all t1: Type, t2: Type | t1 in t2.subtype <-> ( t1.valid_for.satisfies_type=t2)
}
def supertype{
    all t1: Type, t2: Type | t2 in t1.supertype <-> ( t1.valid_for.satisfies_type=t2)
}
def subclass {
    all c1: Class, c2: Class | c1 in c2.subclass <-> ( c1.associated_type in c2.associated_type.subtype)
}
def superclass {
    all c1: Class, c2: Class | c2 in c1.superclass <-> ( c1.associated_type in c2.associated_type.subtype)
}
def Template {
    all tpl: Template | tpl.instantiation.specification = tpl
    //recurrence is introduced in RM-ODP: 2-9.11 references 2-9.13 and vice versa
}
def associated_template_type {
    all c: Class, t: Type, tc: TemplateClass, tt: TemplateType | ((c.associated_type = t) &&
(tc.associated_template_type = tt)) <-> ((tt = t) && (tc = c))
}
def member_of_template_class {
    all ii: Instantiation, tc: TemplateClass, i: Instance, c: Class | ((i.member_of_class = c) &&
(ii.member_of_template_class = tc)) <-> ((i = ii) && (tc = c))
}
def derived_class {
    all tc1: TemplateClass, tc2: TemplateClass | tc1.derived_class = tc2 <->
tc1.set_of_instantiations.specification.incremental_modification.instantiation.member_of_template_class = tc2
}
def Composition {
    all c: Composition | one a1:X | some a2:X | one a3:X | a1+a2=a3 <-> (c = a1.mappedToSC) && (c =
a2.mappedToSC)
}
def Decomposition {
    all d: Decomposition | one a1:X | some a2:X | one a3:X | a1+a2=a3 <-> d = a3.mappedToSC
}
def refinement {
    all spec1: SpecificationConcepts, spec2: SpecificationConcepts | some d: SpecificationConcepts |
(spec1.refinement = spec2) -> (spec1+d=spec2)
}
def Type {
    all t: Type | some x:X | x.mappedToSC = t
}
}

/* definitions for "Specific Specification concepts" (RM-ODP 2.9) */

def composite_object {
    all d: Decomposition | one o: Object | (d.composite_object = o) <-> ((d.mappedToBMC = o) &&
(o.mappedToSC = d))
}
def interface_signature{
    all t: Template, i: Interface, a: Interaction | (t.interface_signature = i) <-> a in i && t in a.mappedToSC && a
in t.mappedToBMC
}
def Role{
    all id: Role | one b:Behavior | b.mappedToSC = id
}
def Invariant{
    all i: Invariant | some o: Object | o.mappedToSC = i
}
}

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def Precondition{
    all prec: Precondition | some a : Action | one s : State_ | a.mappedToSC = prec &&
a.instant_begin.state_existence = s
}
def Postcondition{
    all postc: Postcondition | some a : Action | one s : State_ | a.mappedToSC = postc &&
a.instant_end.state_existence = s
}

/* Instantiate and Deletion operations (RM-ODP 2.9) */

op Instantiate (i: Instantiation, bmc: BasicModellingConcepts, new_bmc: BasicModellingConcepts', new_i: Instantia-
tion', x:X!, ix: Instantiation!) {
    x not in bmc
    ix not in i
    new_bmc = bmc + x
    new_i = i + ix
    x.mappedToSC' = ix
    ix.mappedToBMC' = x
}

op Deletion (i: Instantiation, bmc: BasicModellingConcepts, new_bmc: BasicModellingConcepts', new_i: Instantia-
tion', x:X!, ix: Instantiation!) {
    x in bmc
    ix in i
    x.mappedToSC = ix
    ix.mappedToBMC = x
    new_bmc = bmc - x
    new_i = i - ix
    x not in new_bmc
    ix not in new_i
}

}
}
/* ----- end of code -----*/

```

References

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