Semantic SLAs for Services with Q-SLA

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Outline

- Problematic
- Contribution
- OWL-Q Update
- Q-SLA Analysis
- Example
- Future Work

Problematic

- Proliferation of services
  - QoS crucial role in discovery & management of service-based applications (SBAs)
- Appropriate description of service/SBA QoS
  - Two broad categories of approaches:
    - Service description languages: until service discovery activity
    - Service Level Agreements (SLAs): whole management lifecycle covered
- Main SLA language issues:
  - Lack of formality
  - Lack of extensiveness
    - Service lifecycle not well covered
  - No specification of quality terms

Contribution

- Rely on OWL-Q semantic service description language
  - Update/Improve language based on evaluation results in [1]
- Extend OWL-Q to specify SLAs
  - Extensive coverage of SLA domain
  - Better satisfaction of SLA evaluation criteria in [1]
  - Use of rules for semantic SLA model validation & added-value knowledge production
- End result:
  - Full-fledged SLA language covering also the full semantic definition of QoS terms
  - Syntactic & semantic validation of SLA models
    - Guidance in correct SLA model production
  - Exploit existing OWL-Q tools spanning service specification alignment [2], service discovery [3] & service negotiation [4]

OWL-Q Refactoring

- Refactoring focusing on:
  - OWL-Q compactness
    - Achievement: Reduction of facets, concepts & properties
    - Benefit: more focused (domain) modelling & less modelling effort
  - Better rule support:
    - Achievement: incorporation of additional rules
    - Benefit: enhanced validation & added-value knowledge production (e.g., concept matching rules)
- Refactoring result:
  - 6 core facets focusing on generic, attribute, metric, value type & unit conceptualisations
  - More than 30 facet-specific or cross-facet rules

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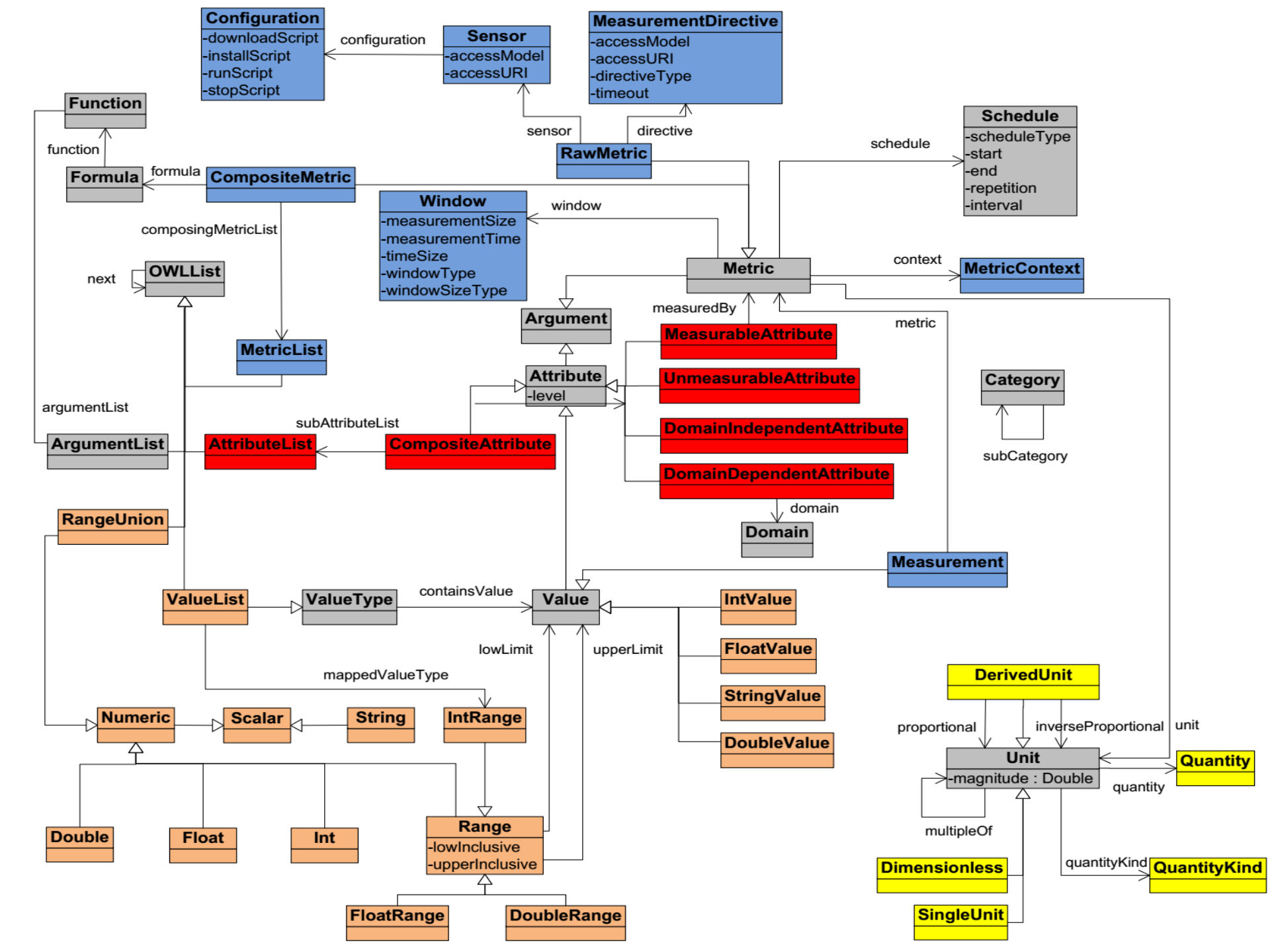
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-installScript
-runScript
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Sensor
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-accessURI
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-timeout
sensor
directive
Function
function
Formula
formula
CompositeMetric
RawMetric
schedule
Schedule
-scheduleType
-start
-end
-repetition
-interval
Window
-measurementSize
-measurementTime
-timeSize
-windowType
-windowSizeType
window
composingMetricList
next
OWLList
Metric
context
MetricContext
measuredBy
metric
Argument
MeasurableAttribute
UnmeasurableAttribute
DomainIndependentAttribute
DomainDependentAttribute
Attribute
-level
Category
subCategory
MetricList
argumentList
subAttributeList
ArgumentList
AttributeList
CompositeAttribute
domain
Domain
RangeUnion
Measurement
ValueList
ValueType
containsValue
Value
IntValue
FloatValue
StringValue
DoubleValue
lowLimit
upperLimit
mappedValueType
Numeric
Scalar
String
IntRange
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inverseProportional
unit
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-magnitude : Double
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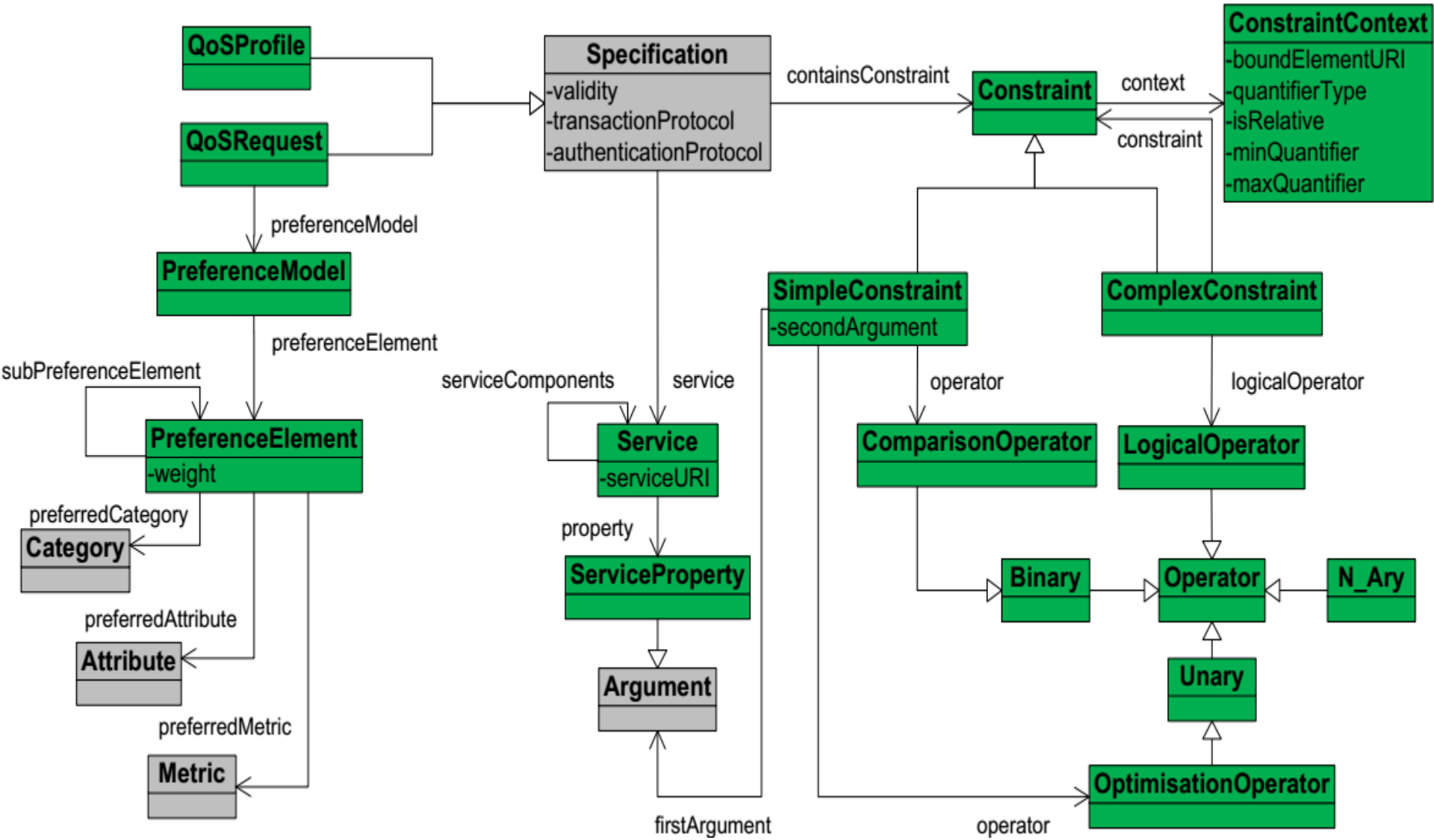

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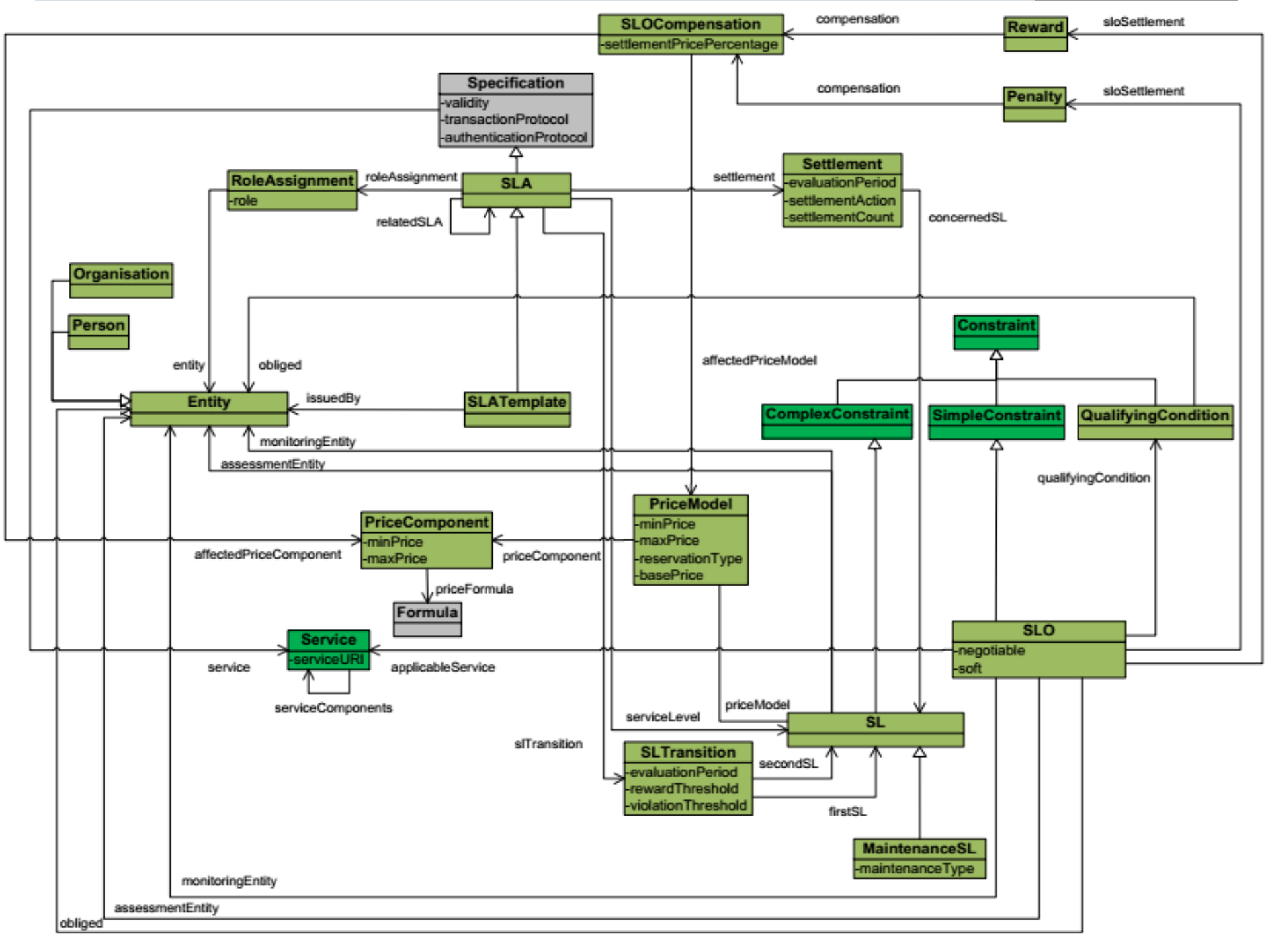
Q-SLA

- Main Features:
  - Coverage of QoS terms via OWL-Q
    - Extension of existing concepts plus creation of new (purely SLA-based) ones
  - Better & explicit coverage of service levels (SLs)
    - SL as composite constraint
    - Coverage of different classes of consumers
  - Incorporation of capability to transit between SLs
    - Less need for re-negotiation
    - Automatic transit when certain conditions hold
    - Capture of transitions to maintenance SL
  - Coverage of (critical) SLA termination conditions
  - Coverage of SLOs, qualifying conditions as well as penalties/rewards
  - Coverage of service price model
  - Light SLA composition supported
  - Inclusion of specification plus SLA rules for semantic validation & SLA concept matching

Q-SLA Comparison with Related Work

Life-cycle Activity	Criteria	WSLA [7]	WS-A [8]	WSOL [9]	RBSLA [10]	LUA [11]	SLALOM [12]	Q-SLA
Description	Formalism	Informal	Informal	Informal	RuleML Ontologies	Ontology	UML	Ontology
	Coverage	[p,y]	[y,p]	[p,p]	[p,y]	[y,y]	[p,y]	[p,y]
	Reusability	yes	yes	yes	yes	yes	yes	yes
	Composability	no	fair	no	no	no	no	fair
Matchmaking	Metric Definition	yes	no	no	yes	no	yes	yes
	Alternatives	impl	impl	impl	impl	no	no	yes
	Soft Constraints	no	yes	no	no	no	no	yes
	Matchmaking Metric	no	no	no	no	no	no	yes
Negotiation	Meta-Negotiation	poor	fair	poor	poor	no	no	good
	Negotiability	no	part	no	no	no	no	yes
Monitoring	Metric Provider	yes	no	yes	no	yes	no	yes
	Metric Schedule	yes	no	no	yes	yes	no	yes
Assessment	Condition Evaluator	yes	no	yes	no	yes	no	yes
	Qualifying Condition	impl	yes	no	no	yes	no	yes
	Obliged	yes	yes	yes	yes	yes	yes	yes
	Assessment Schedule	yes	no	no	no	yes	no	yes
	Validity Period	yes	no	no	yes	yes	no	yes
	Recovery Actions	yes	no	yes	yes	no	no	no
Settlement	Penalties	no	SLO	SL	SL	SLO	SLO	SLO
	Rewards	no	SLO	no	SL	SLO	no	SLO
	Settlement Actions	yes	no	no	yes	no	no	yes
Archive	Validity Period	yes	yes	no	no	yes	yes	yes


SLOCompensation
-settlementPricePercentage
compensation
Reward
sloSettlement
Specification
-validity
-transactionProtocol
-authenticationProtocol
compensation
Penalty
sloSettlement
RoleAssignment
-role
roleAssignment
SLA
settlement
Settlement
-evaluationPeriod
-settlementAction
-settlementCount
relatedSLA
concernedSL
Organisation
Person
Constraint
entity
obliged
affectedPriceModel
Entity
issuedBy
SLATemplate
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assessmentEntity
qualifyingCondition
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-minPrice
-maxPrice
-reservationType
-basePrice
PriceComponent
-minPrice
-maxPrice
affectedPriceComponent
priceComponent
priceFormula
Formula
Service
-serviceURI
SLO
-negotiable
-soft
service
applicableService
serviceComponents
serviceLevel
priceModel
SL
slTransition
SLTransition
-evaluationPeriod
-rewardThreshold
-violationThreshold
secondSL
firstSL
MaintenanceSL
-maintenanceType
monitoringEntity
assessmentEntity
obliged

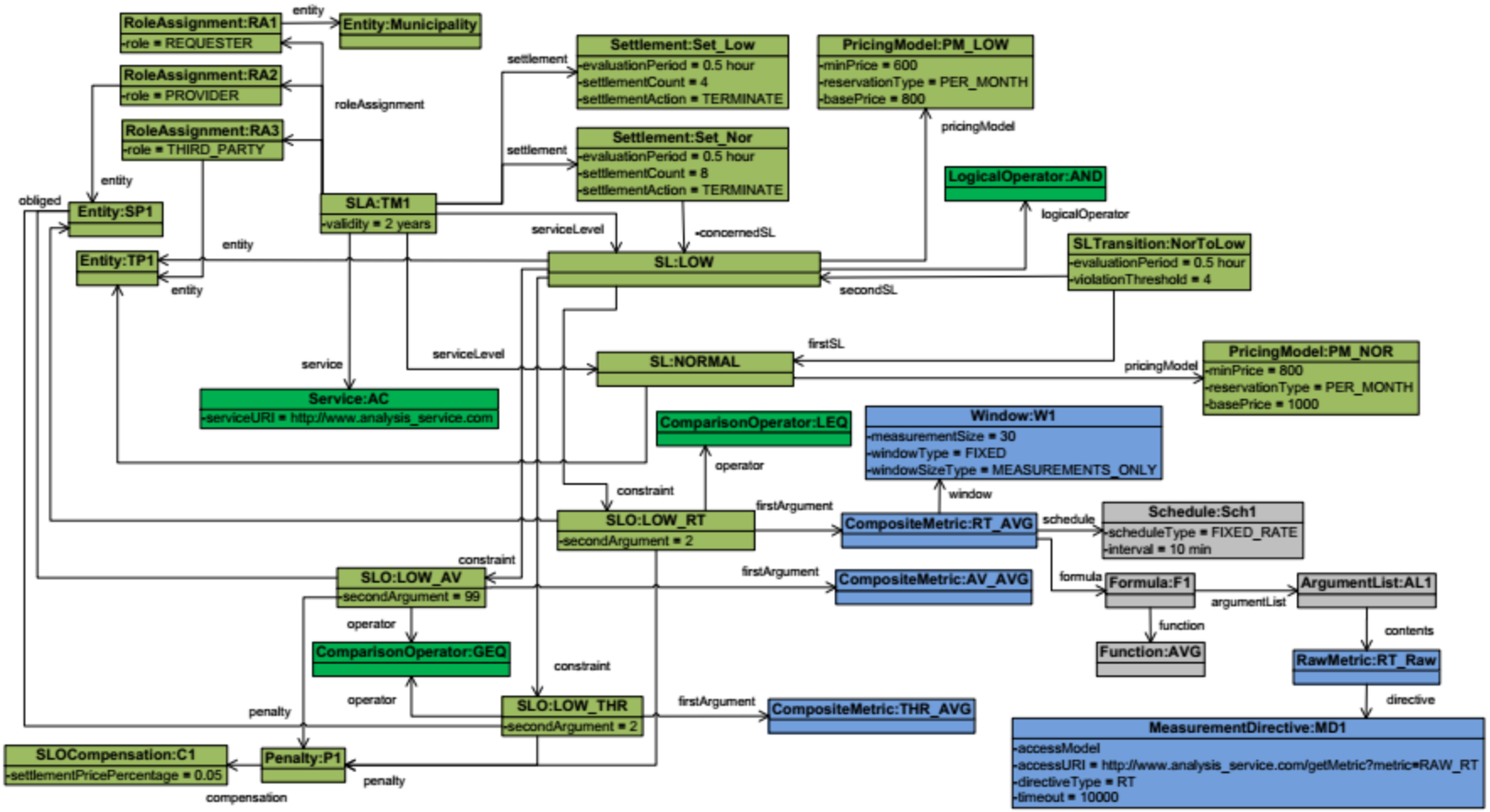
Example – Traffic Management SBA

- 3 components involved (sensing, analysis, plan enforcement)
  - Analysis component outsourced
- SLA for analysis component:
  - 2 years validity period
  - 3 SLs:
    - Normal: *rt* ≤ 1 min, *av* ≥ 99.99%, *thr* ≥ 6 reqs/min
    - Low: *rt* ≤ 2 min, *av* ≥ 99%, *thr* ≥ 2 reqs/min
    - Maintenance: *rt* ≤ 6 min, *av* ≥ 80%, *thr* ≥ 0.5 reqs/min
  - SL transitions:
    - To maintenance: midnight for 1 hour
    - Normal_to_low: 4 SLO violations within half an hour
  - Termination conditions: 4 SLO violations for low SL within 0.5 hour

Example (cont.)

- SLA for analysis component (cont.)
  - Pricing:
    - 1000 euros per month for normal SL, 800 euros for low SL
    - 800 euros limit for normal SL, 600 euros for low SL
  - SLO violation:
    - 5% discount of base price
  - Metrics:
    - Average response time with 10 min schedule & 30 measurements window
    - Average availability with 10 min schedule & 10 measurements window
    - Average throughput with 10 min schedule & 5 measurements window

Example (Visualisation)



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Future Work

- OWL-Q/Q-SLA Validation
- Complete SLA relationship handling
- OWL-Q/Q-SLA Editor
  - No need to know OWL-Q to specify SLAs
- Complete Service Management Framework based on OWL-Q
- Transformation from non-OWL-Q models to OWL-Q ones
  - Support to some well-adopted languages like WS-Agreement

References

1. Kritikos, K., Pernici, B., Plebani, P., Cappiello, C., Comuzzi, M., Benbernou, S., et al. A Survey on Service Quality Description. *ACM Computing Surveys* 2013;**46**(1).
2. Kritikos, K., Plexousakis, D.. *Towards Aligning and Matchmaking QoS-based Web Service Specifications*; chap. 1. USA: IGI Global. ISBN 0932764460; 2012, p. 216 – 257.
3. Kritikos, K., Plexousakis, D.. Novel optimal and scalable nonfunctional service matchmaking techniques. *IEEE T Services Computing* 2014;**7**(4):614–627. doi:10.1109/TSC.2013.11.
4. Comuzzi, M., Kritikos, K., Plebani, P.. A Semantic Based Framework for Supporting Negotiation in Service Oriented Architectures. In *CEC.* 2009, p. 137-145.