Introducing the Validation Mechanism of the Dynamic Multi-Layer Algebra

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Outline

1. What is Multi-Level Modeling?
2. Dynamic Multi-Layer Algebra (DMLA)
3. Validation mechanism of DMLA
4. Conclusions

Introduction

What is multi-level modeling?

The evolution of concepts

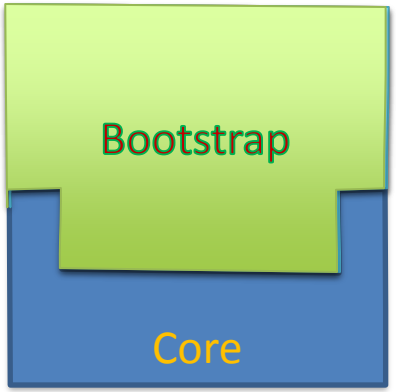
- Software evolution
  - Starts from *Something*
  - Ends with a *concrete product*
  - During the evolution
    - Abstraction level is reduced
    - Level of freedom is decreased
- Classic object-oriented method
  - Two-level style (Fixed number of abstraction levels)
  - Classes and objects
  - Limitations

Multi-level metamodeling

Dynamic Multi-Layer Algebra (DMLA)

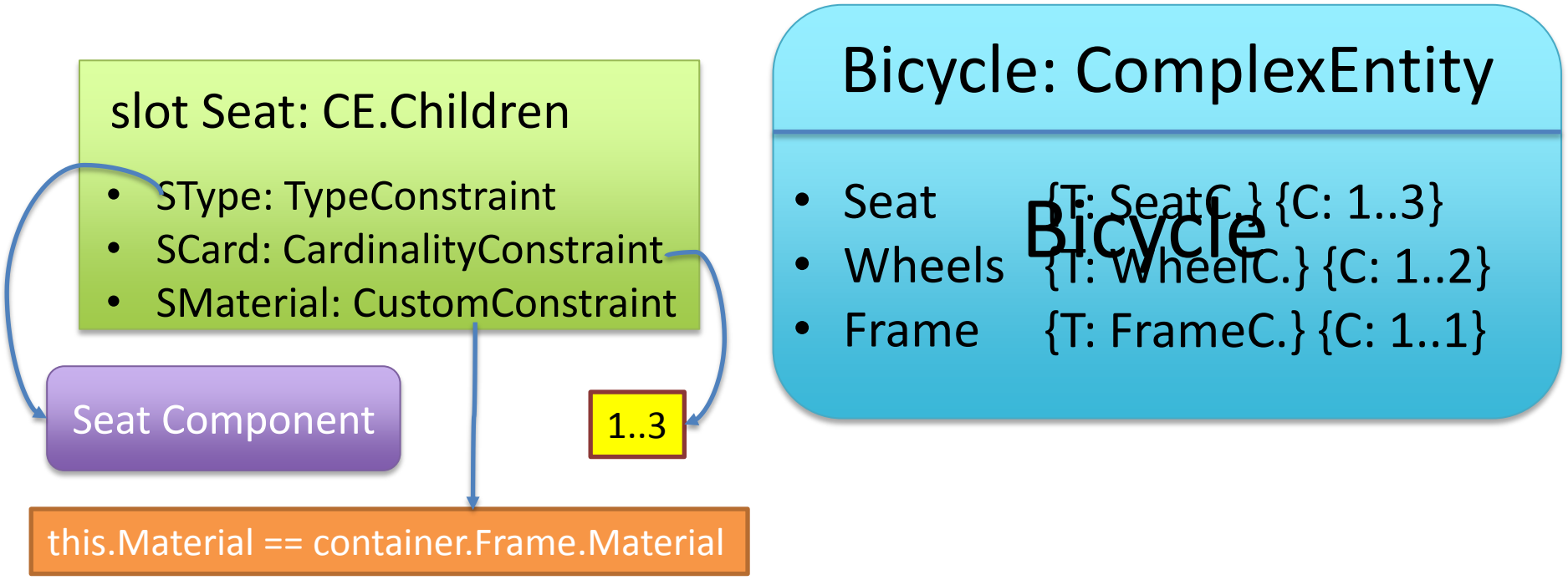
DMLA: Core - Bootstrap

- Core (the “HW”)
  - Based on Abstract State Machines
  - *Data structure* and *management*
  - 4-tuple {ID, Meta, Values, Attributes}
- Bootstrap (the “operating system”)
  - Set of entities, enabler of modeling
  - Defines metamodeling foundation
  - *Basic building blocks* (modelling+operations)
  - Can be replaced with another bootstrap



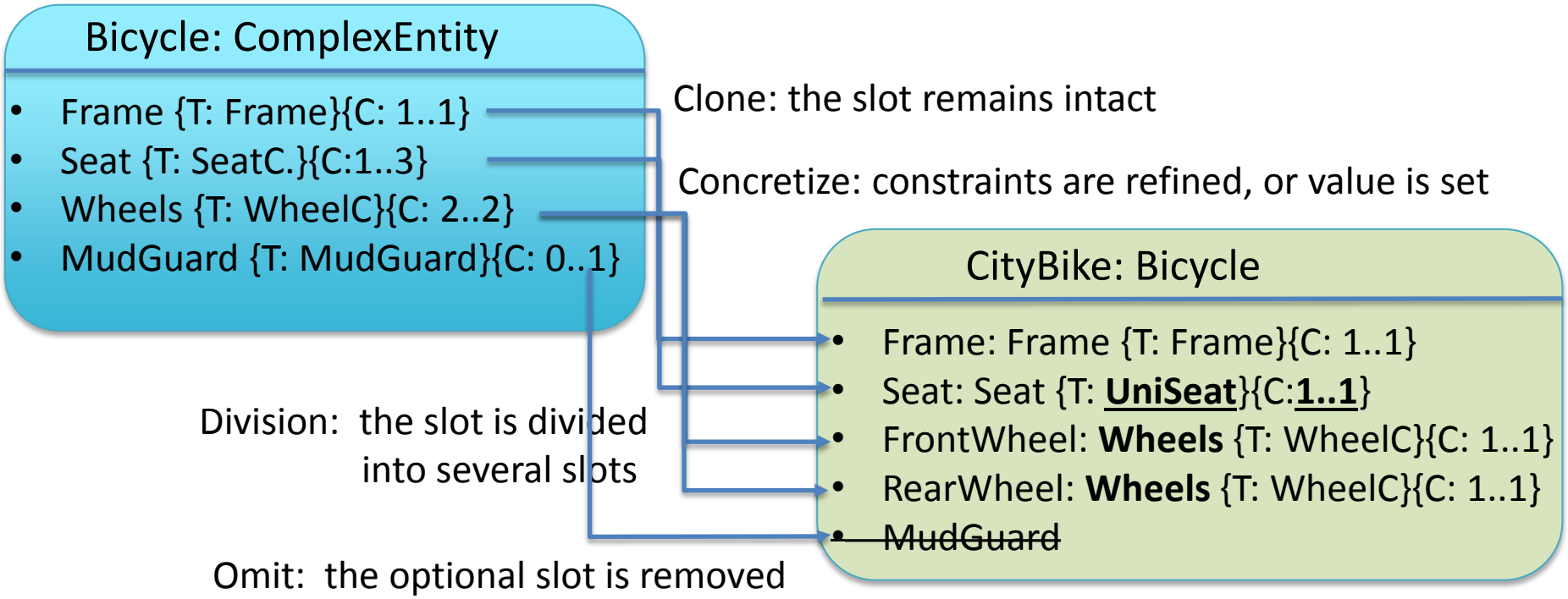
DMLA: Entities and slots

- Entity
- Slot (placeholder for the value + constraints)



DMLA: Entities and slots

- Slot behavior
  - Clone: the slot remains intact
  - Concretize: constraints are refined, or value is set
  - Division: the slot is divided into several slots
  - Omit: the optional slot is removed



Validation Mechanism of DMLA

DMLA – Validated operations

- Goal: self validating Bootstrap (without an external language)
- Key: we need to *model the operations*
- AST elements → Bootstrap
- Java executor for carrying out the validation
- Operation definitions are built from entities

  → A high level script language (DMLAScript)

Alpha formulae

- Meta – instance (1:1, e.g. type)
- **REQ:** *A professional racing bike has a professional race frame which is made of aluminum or carbon and has a minimum weight of 5200 gr.*

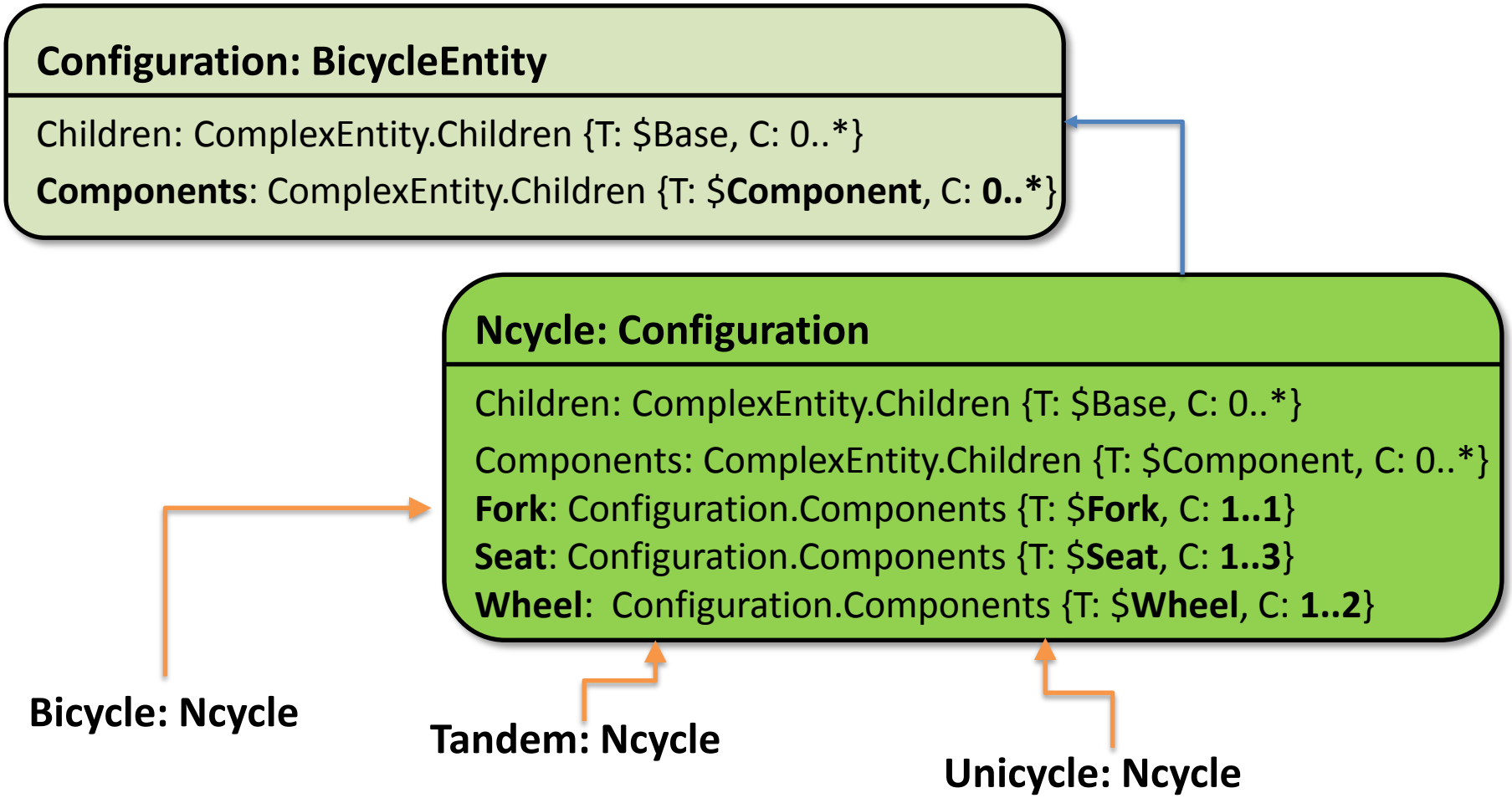
```
operation Bool ID::ProRaceFrameAlpha(ID instance){

    ID material = call $GetRelevantAttributeValue(instance, $BicycleComponent.Material)
    if (material!=null  && material!=$Material_Carbon
                        && material!=$Material_Aluminium) return false;

    Number weight= call $GetRelevantAttributeValue(instance, $Component.Weight);
    if (weight!=null&& weight>5200) return false;

    return true;
}
```

Beta formulae (1:n)



Gamma formulae

- Instance – whole model (1:*, e.g. uniqueness)
- **REQ:** *Components must have a unique serial number.*

```
slot SerialNumber: ComplexEntity.Children;


@Base.GammaValidation.C
@Base.GammaValidation.T
@Base.GammaValidation.OpSig
slot ComponentGamma : Base.GammaValidation =
    operation Bool ID::UniqueFrameId()
    {
        //...
    }
```

Soft validation in DMLA

- Failing the validation criteria automatically produces invalid models
- One may need a “softer” method that is rather a filtering mechanism
- **REQ:** *A racing bike is not suited for tough terrain.*

```
slot IsSuitable : Bicycle.IsSuitable =
    operation Bool ID::IsSuitableFor_Race(ID checkCondition){
        if (checkCondition == $SuitableFor_ToughTerrain)
            return false;
        else
            return true;
    }
```

Conclusions

Conclusions

- Limitations:
  - Parallel and incremental validation
- Currently working on:
  - VM over DMLA
  - New language over DMLAScript for domain modeling
  - Visualization of the models

References

- Gergely Mezei, Zoltán Theisz, Dániel Urbán, Sándor Bácsi: The bicycle challenge in DMLA, where validation means correct modeling. MODELS Workshops 2018: 643-652
- Sándor Bácsi, Gergely Mezei: Towards a Visualization of Multi-level Metamodeling Techniques. ICSOFT 2018: 389-396
- Z. Theisz, S. Bácsi, G. Mezei, F. A. Somogyi, D. Palatinszky: "By multi-layer to multi-level modeling" in Multi@Models, München, Germany, 2019.
- MULTI 2018 Homepage, https://www.wi-inf.uni-duisburg-essen.de/MULTI2018/

Thank You & Any Questions?

Dynamic Multi-Layer Algebra

http://www.aut.bme.hu/Pages/Research/VMTS/DMLA