Meta Modeling: Re-architecting the UML Infrastructure

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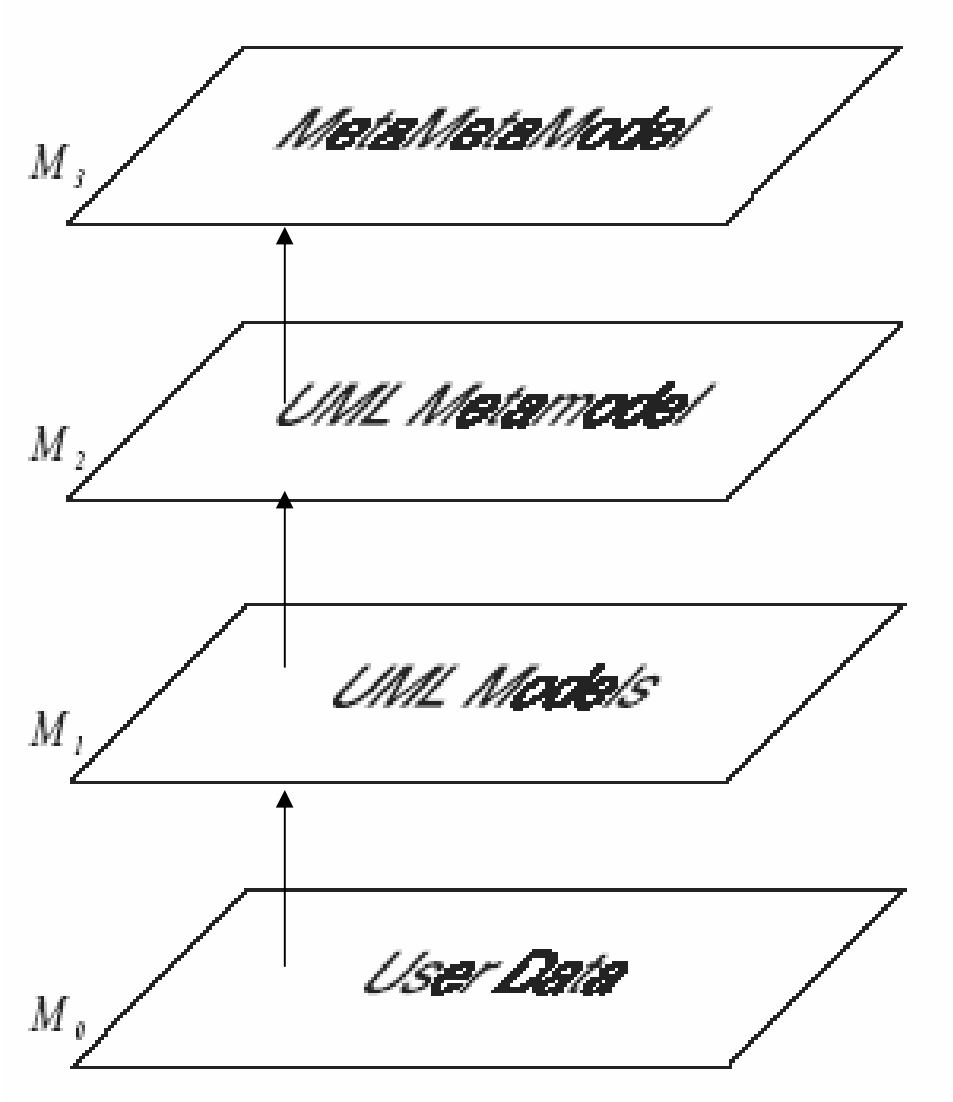
Overview

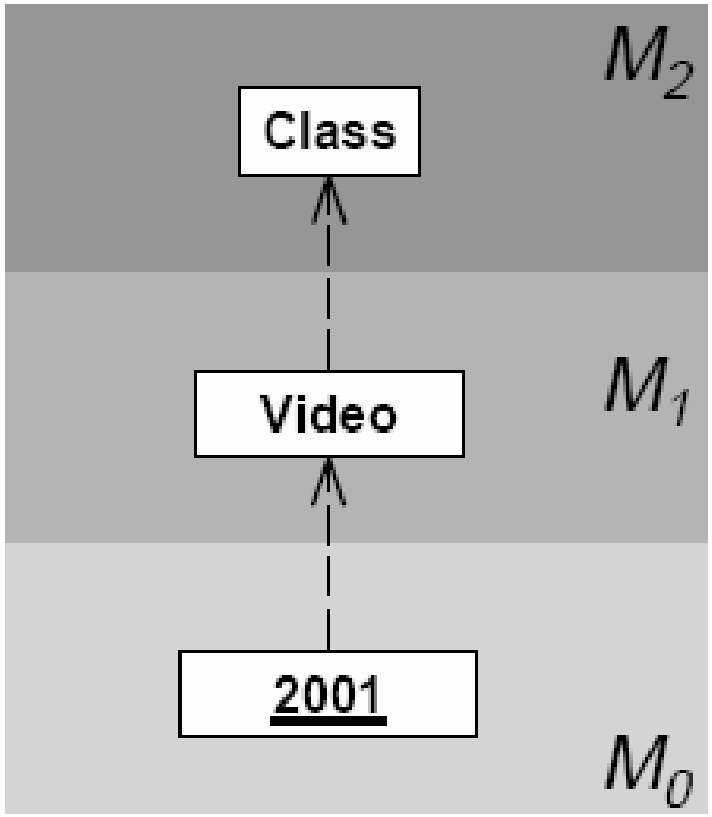
- Current UML Metamodel
- 3 Problems and Proposed Solutions w/ UML Metamodel
- Combining the Proposals

Major Goals of UML 2.0

- Provide an extensible framework.
- Customized abstraction mapping to implementation concepts.
  - E.g. modify concept of class
- No consensus of how to accomplish this.

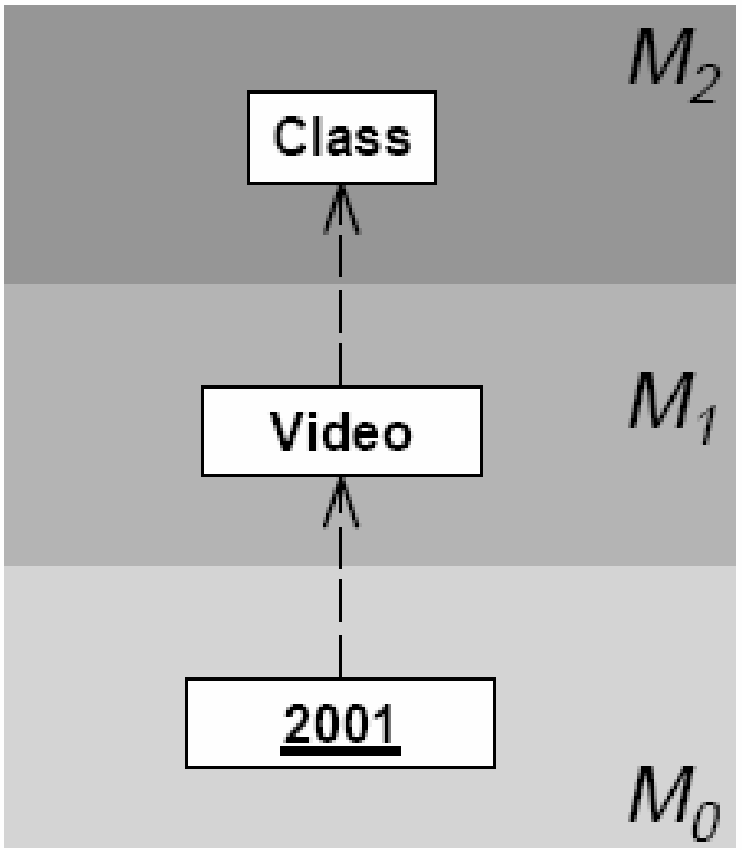
Four Level Metamodeling Architecture





Problems w/ Architecture

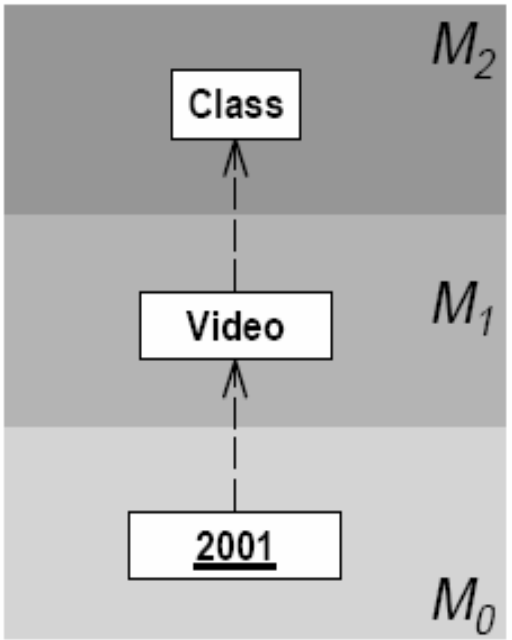
- The “Instance-Of” relationship is:
  - not well defined.
  - not the same between levels.
  - not the same within a level.



Strict Metamodeling

- Improves definition of “Instance-Of” relationships with the constraints:

1. “Instance-Of” relationships only allowed between levels, not within a level.
2. Elements must be an “Instance-Of” exactly one element from the level immediately higher.



Problem I: Instance-Of Types

- Does not recognize and support the two fundamental “Instance-Of” relationship types:
  - Logical Classification
  - Physical Classification

Logical Classification

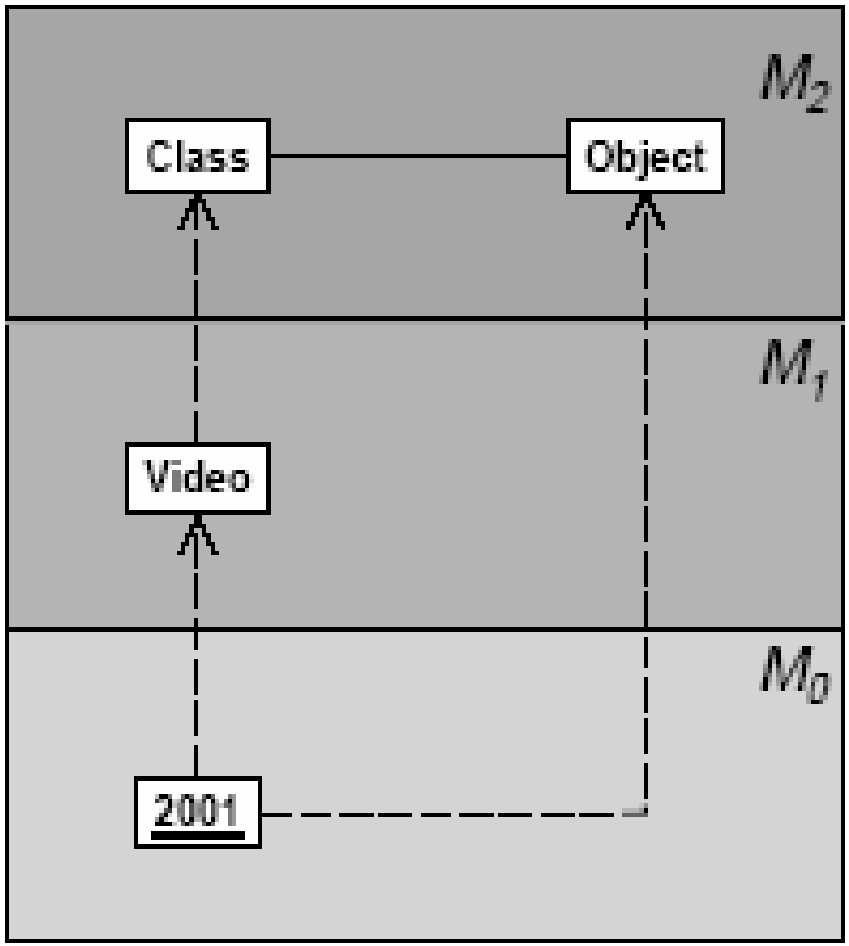
- Defines a model element's domain type and content.
- E.g. *2001: A Space Odyssey* is a Video.
- Dominant classification from modelers point of view.

Physical Classification

- Defines structure and presentation of a model element.
- E.g. *2001: A Space Odyssey* is an Object
- Dominant classification from tool builder's point of view.

Strict Metamodeling Violation

- Integrating both logical and physical into linear hierarchy violates strict metamodeling.

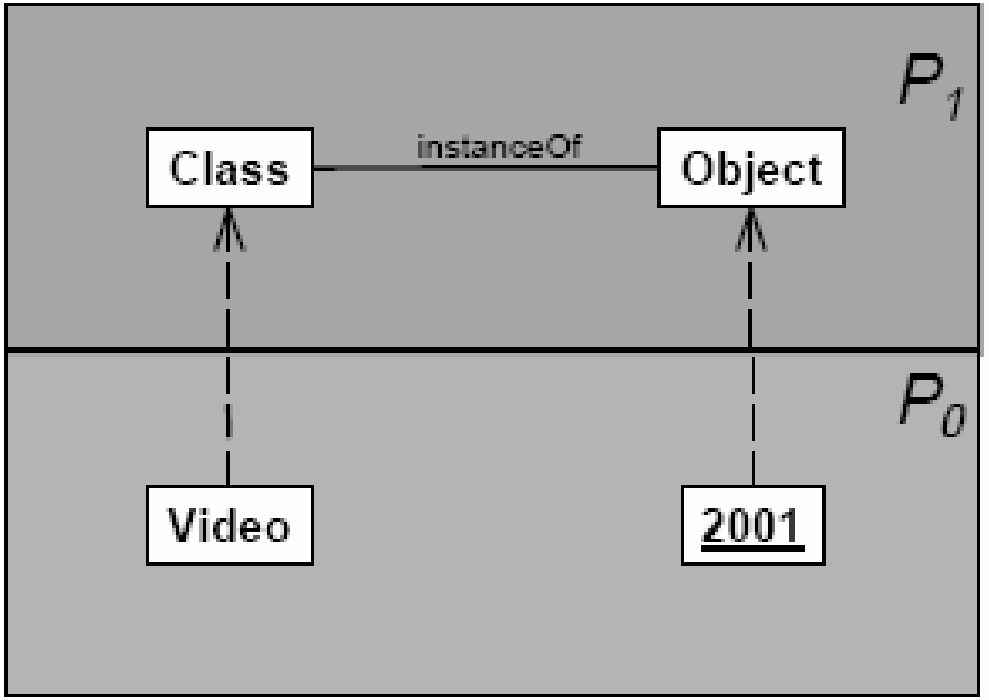


Proposal I: Use Two Metadimensions

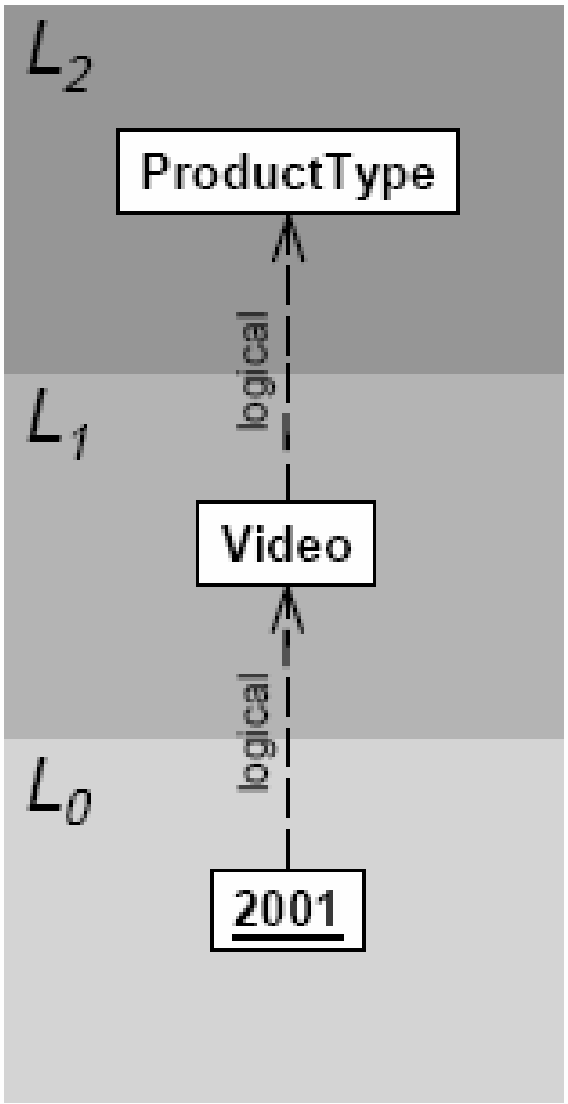
- Explicitly define “Instance-Of” relationships of type logical or physical.
- Split linear hierarchy into logical and physical metadimensions.

Physical Metadimension

- Video has attributes and associations.
- 2001 has slots and links.
- No logical relationship shown.
- Strict metamodeling not violated.

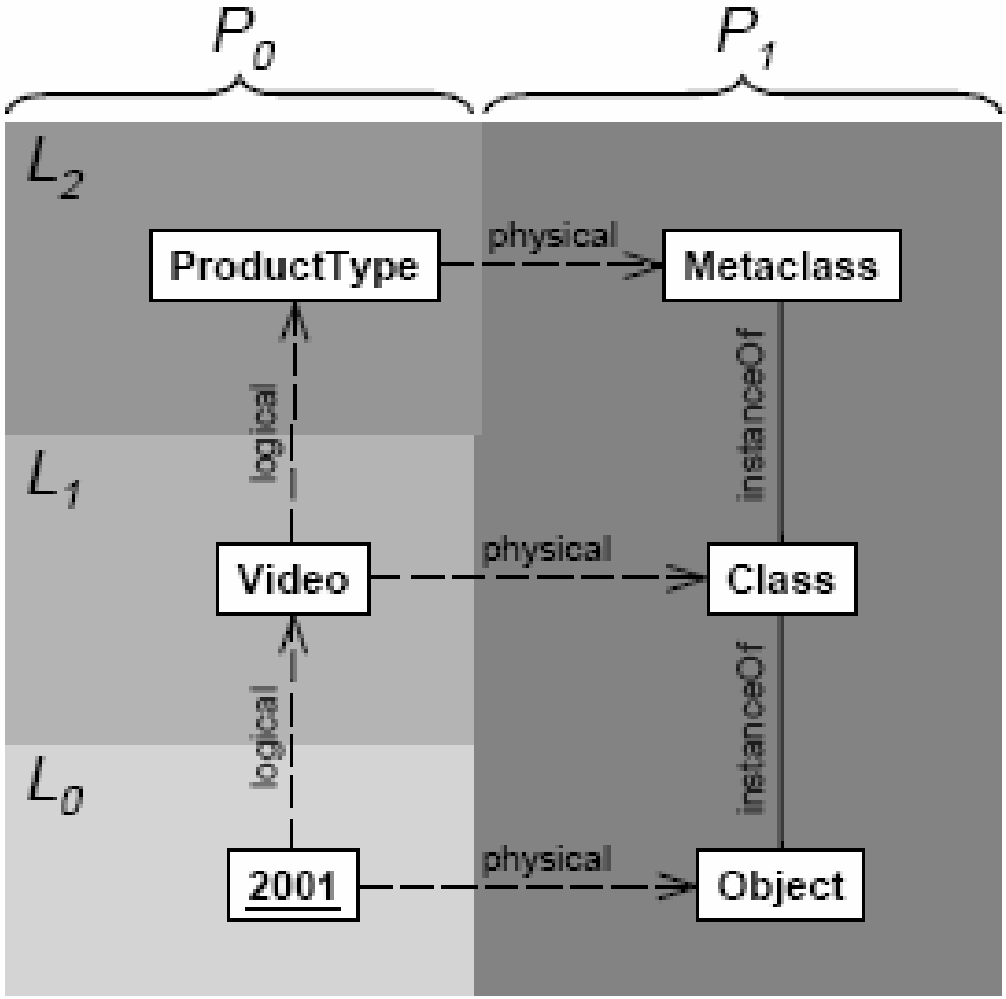


Logical Metadimension



Outcome: Two Dimensional Framework

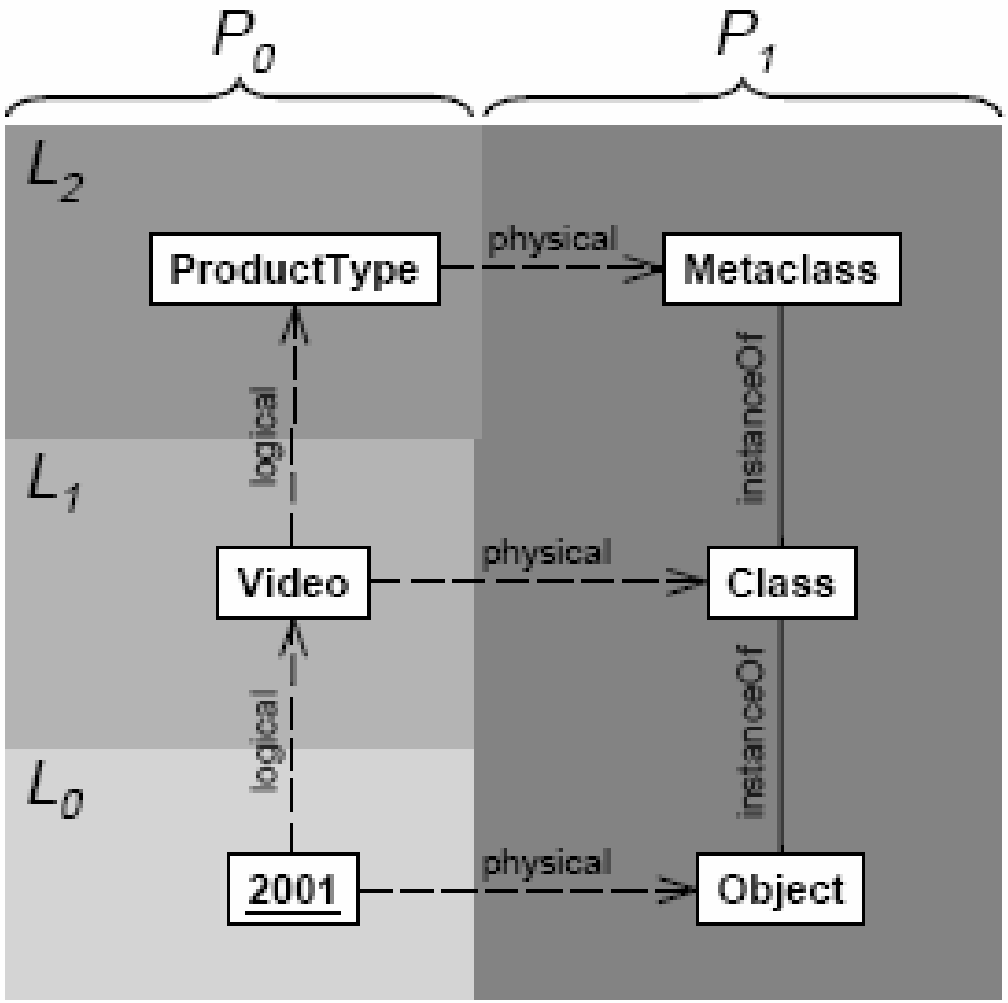
- Logical and physical dimensions are:
  - Orthogonal.
  - Have equal importance
- Strict Metamodeling achieved.



(b)

Problem II: More Logical Metalevels

- Modelers want more logical metalevels.
  - E.g. 2001 is a template for different copies.
- Need corresponding element in P_1.
- Redundant physical classifiers.



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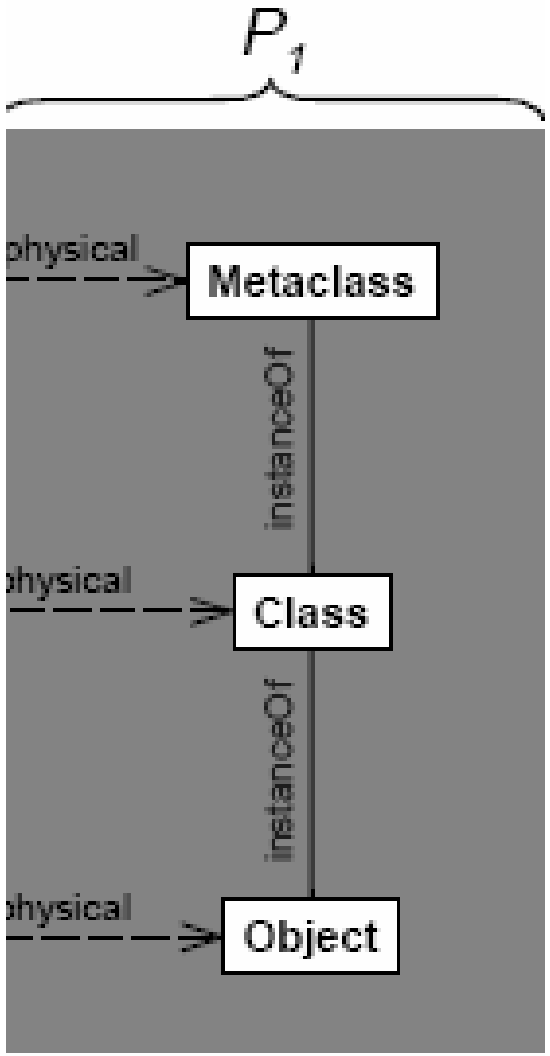
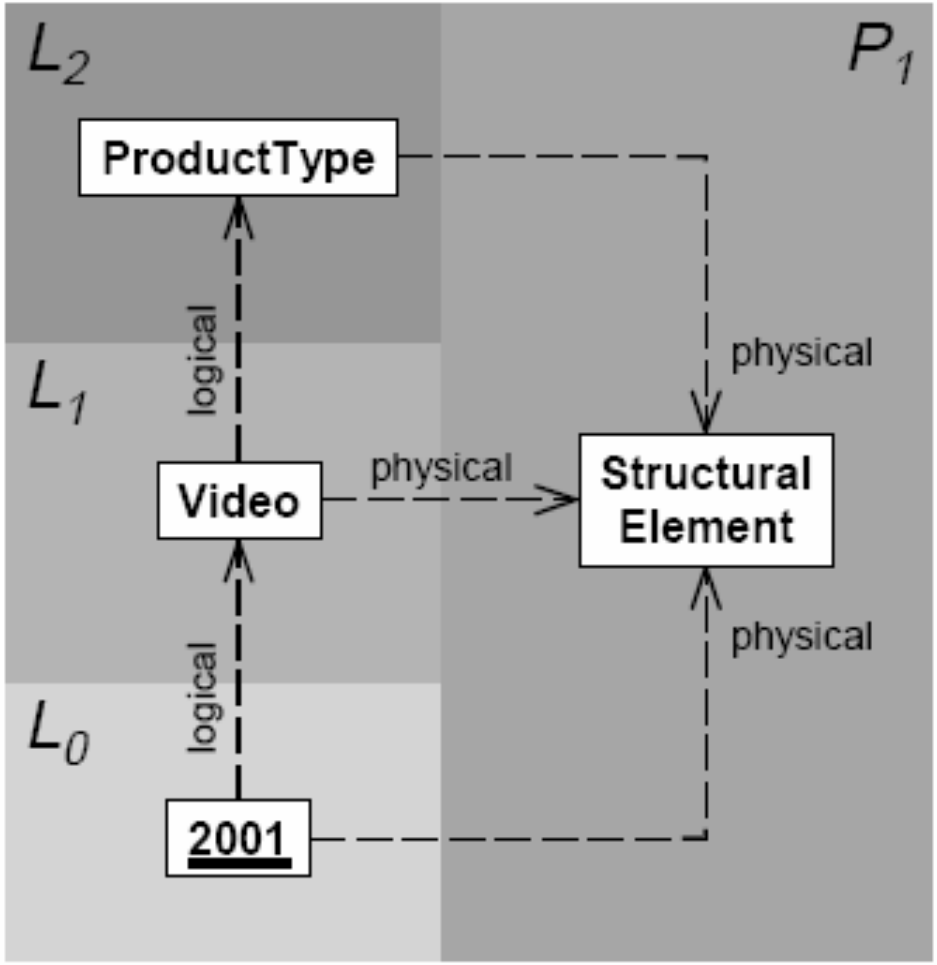
Proposal II: Unify Modeling Elements

- Solution: simplify P_1 by merging all its elements.
- Tradeoff: can not query sets of element types as efficiently.



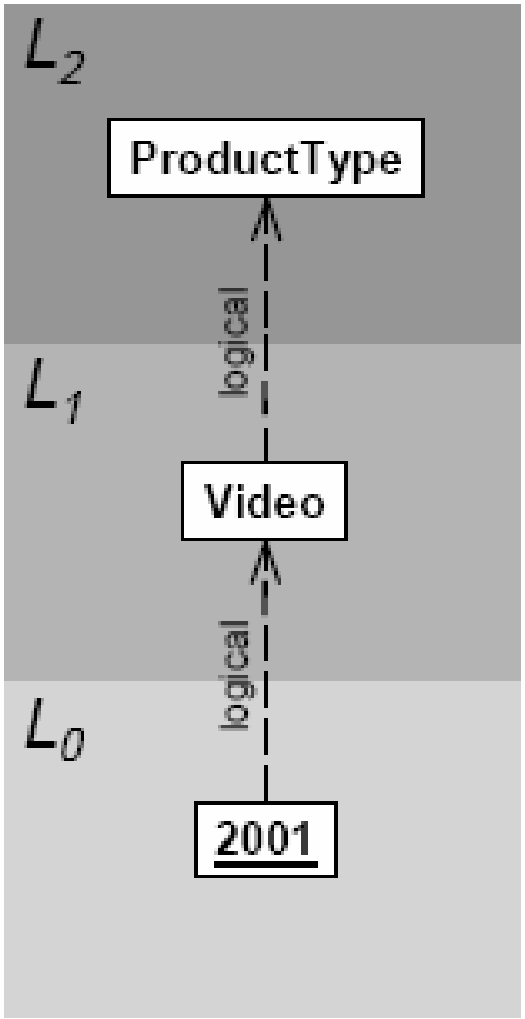
Outcome: Unified Structural Element

- P_0 elements are physical instances of *Structural Element*.
- Number of logical metalevels in P_0 irrelevant.



Problem III: Shallow Instantiation

- Traditional instantiation:
  - can only specify properties of direct instances.
  - can not specify properties of instances of its instances.
- Can not enforce requirements on indirect instances.

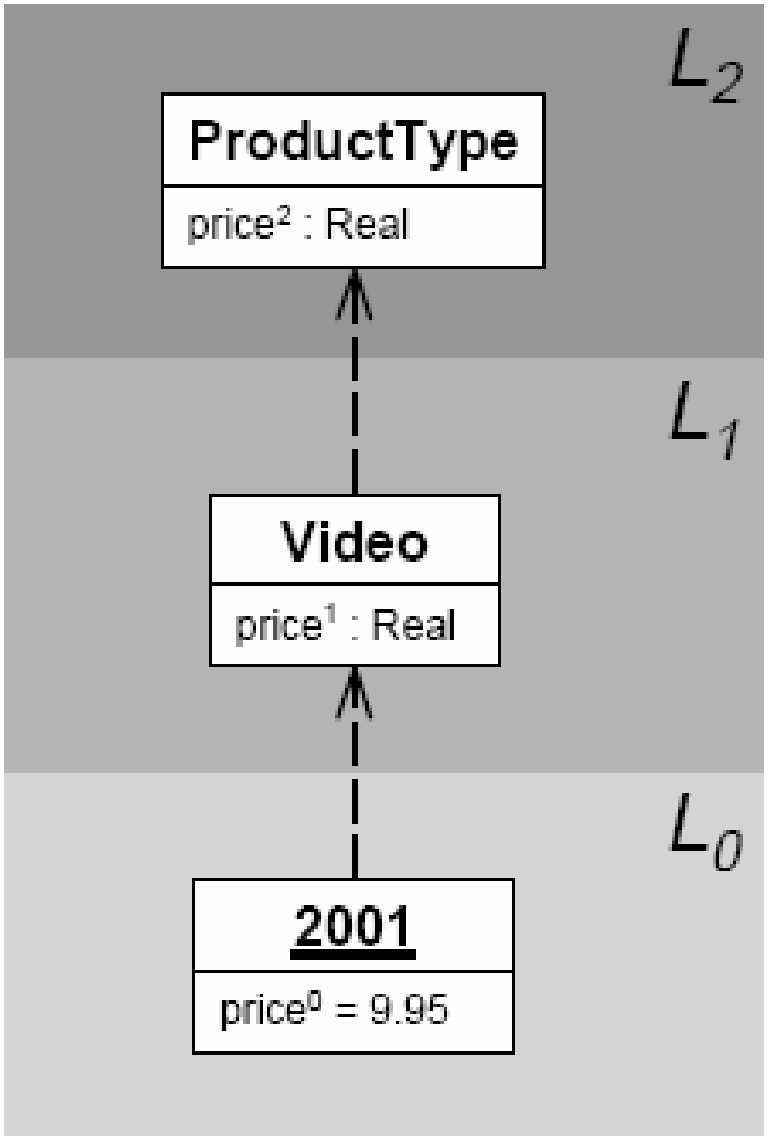


Proposal III: Deep Instantiation

- Assign *potency* value to model elements representing number of instantiations allowed.
- Decrement potency with every instantiations.
- E.g. traditional class: potency = 1
- E.g. traditional object: potency = 0

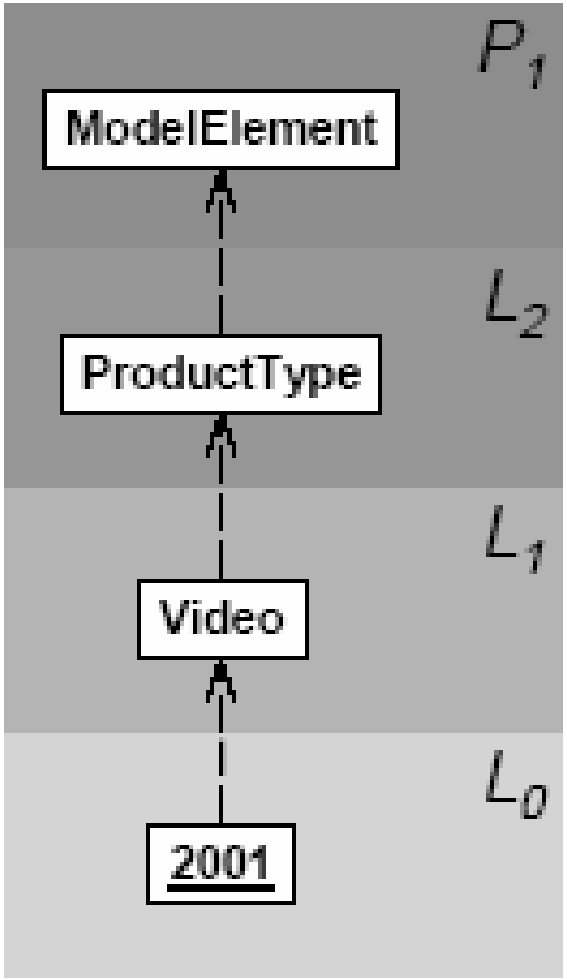
Outcome: Potency

- If more logical levels required then higher potency.
- Information can transcend more than two levels.

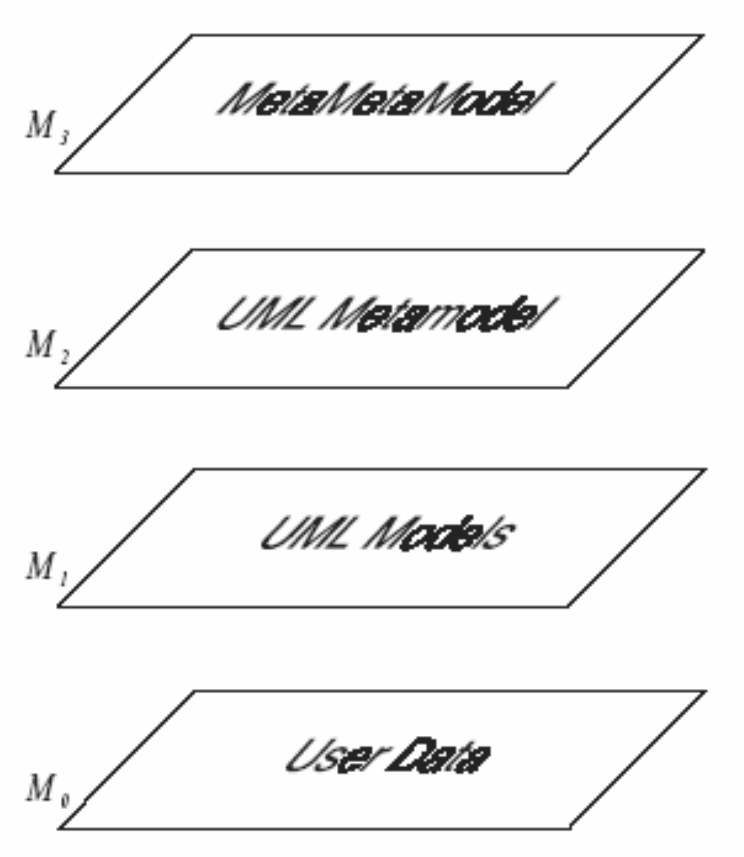


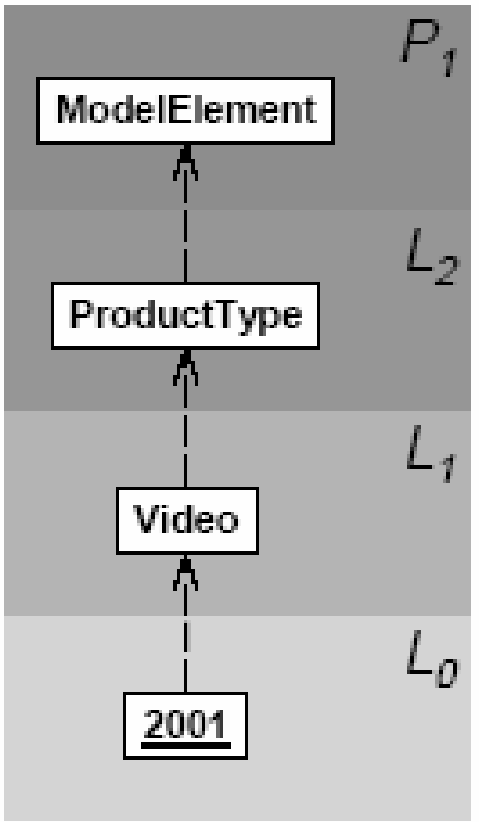
Combine Proposals

- Put P_1 above all logical levels in P_0.
- Recall:
  - One unified structural element for all logical levels.
  - Deep instantiation: information can be defined in a higher level.



Combine Proposals: Outcome





- Logical and Physical re-aligned.
- Proposal I unnecessary?

Conclusion

- 3 Proposals are complementary but independent.
- Help make the UML Metamodel extensible for both tool builders and users.

Questions?

References

- C. Atkinson, T. Kühne. *Rearchitecting the UML Infrastructure,* ACM Journal: Transactions on Modeling and Computer Simulation, Vol. 12, No. 4, 2002.
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