Content Management in the Next Generation Internet

Innovative Uses of the DOI System

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Introduction

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  - Actionable labels
  - Implemented systems

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- This talk will describe how current activities associated with the design of the next generation Internet may impact DRM infrastructures developed around the DOI system.
- We will also describe a demo that implements some interesting rights-related scenarios in a content management setting.

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- These same advances in technology have produced radical shifts in the ability to reproduce and illicitly distribute content.
    - The average high school student today can easily do the amount copying and the volume of distribution that would have required the significant investment of a major corporation only a few years ago.

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The Digital Dilemma – User View

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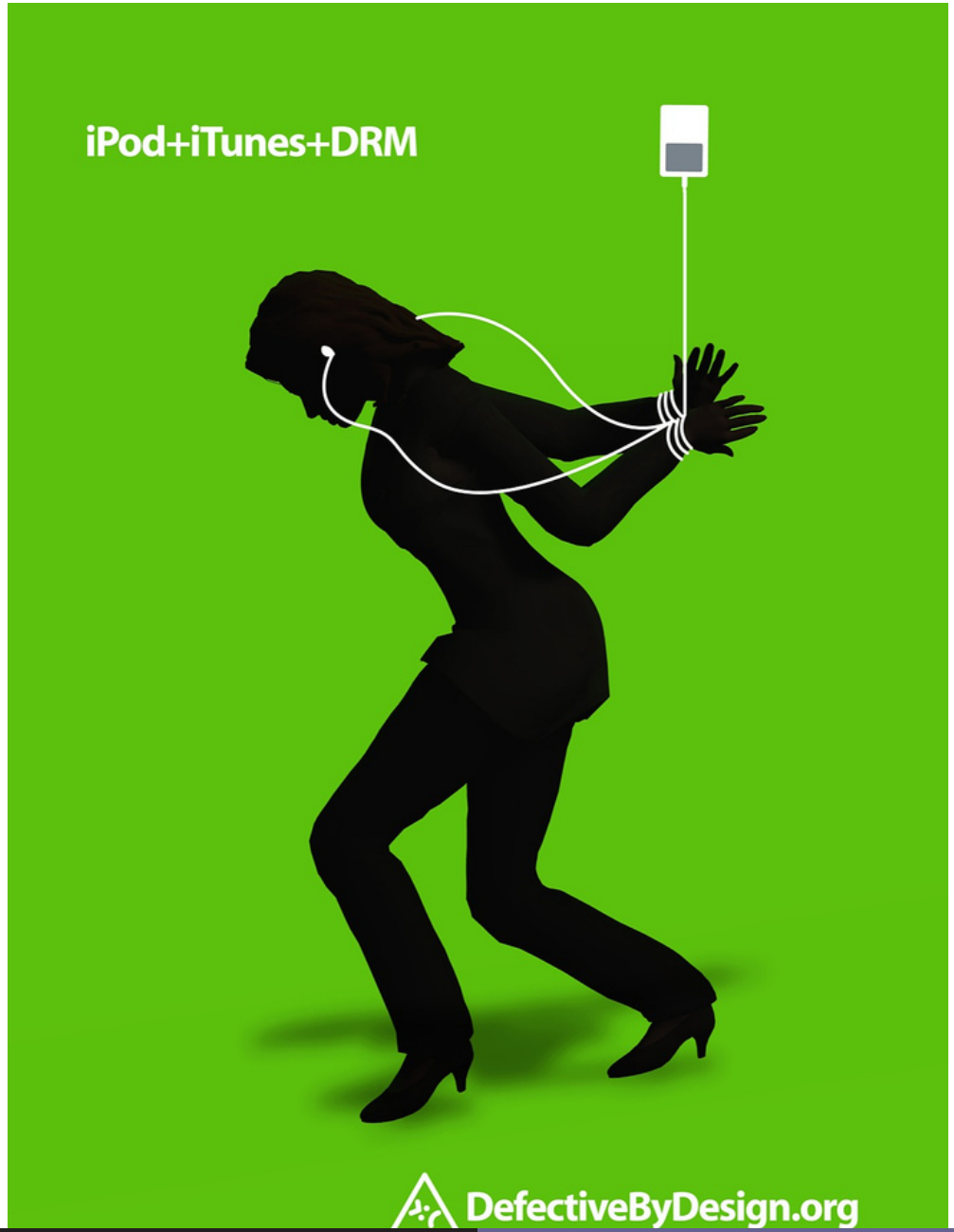

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- DRM poses further challenges that come about due to security-related issues, and these introduce additional barriers to interoperability.

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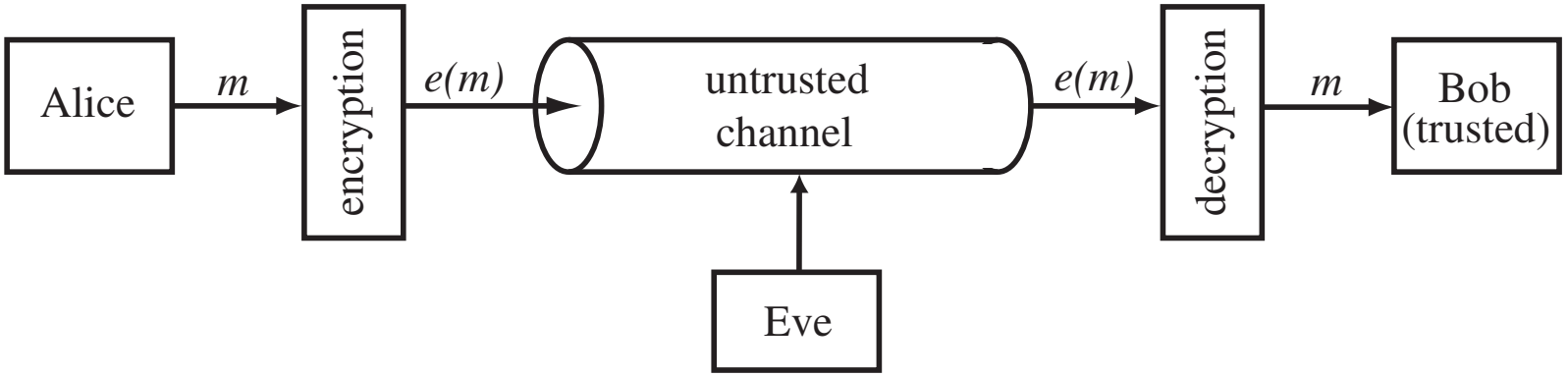

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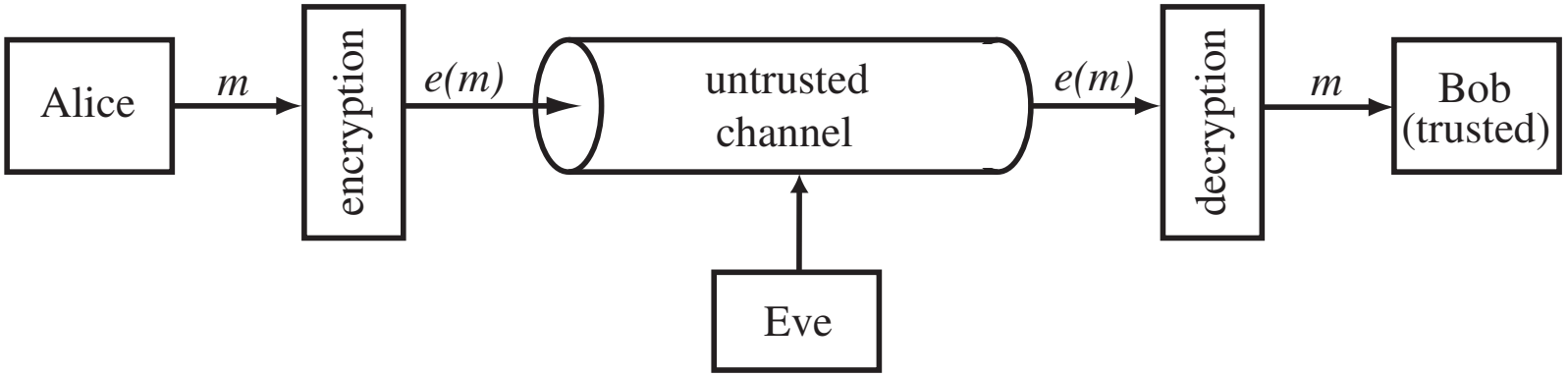

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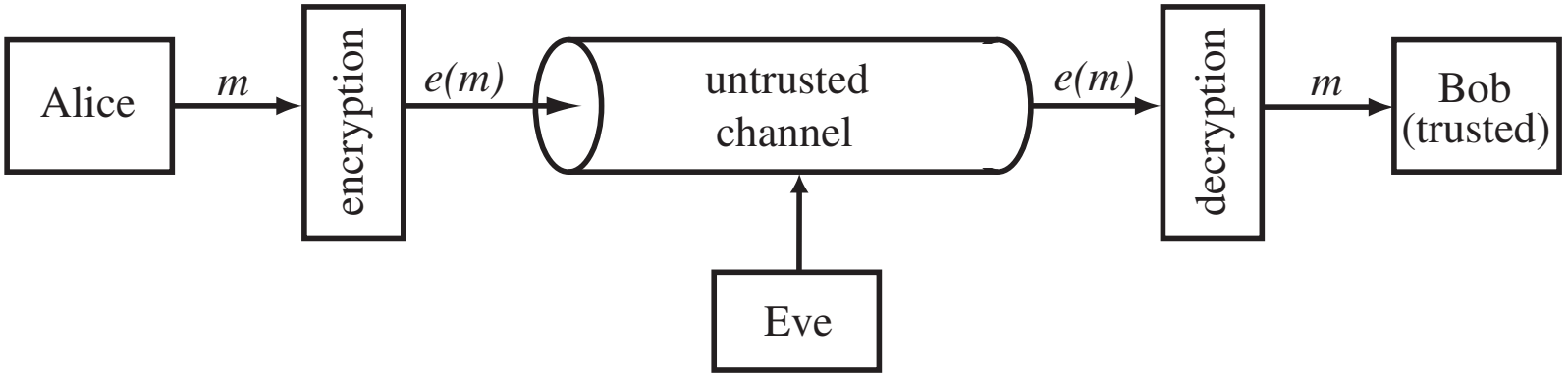

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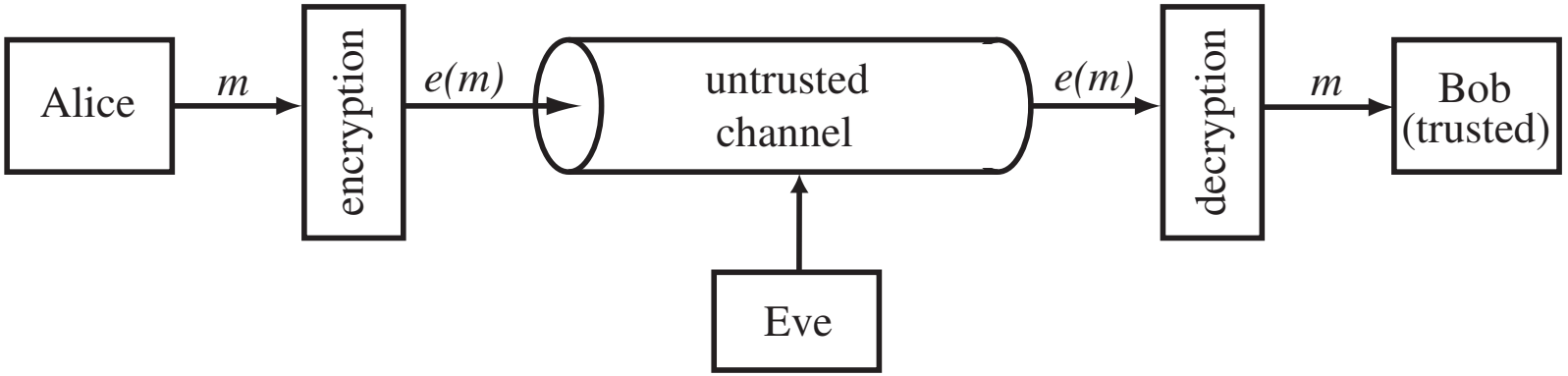

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- Bob has the message in "cleartext", but Alice trusts him to handle it appropriately.
- The are well-defined mathematical notions regarding the capabilities of cryptosystems (e.g., unconditionally secure, computational secure, etc.).

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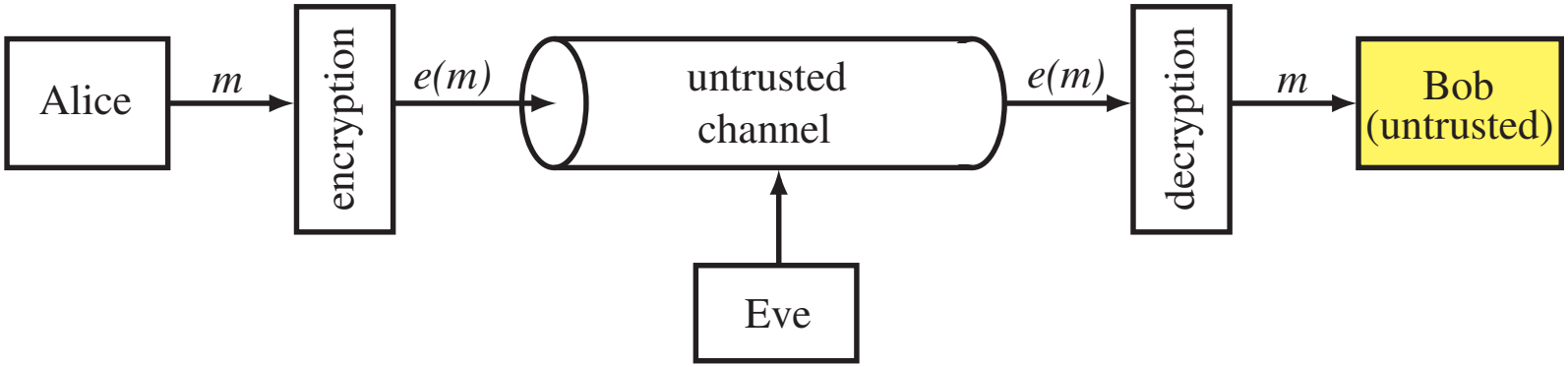

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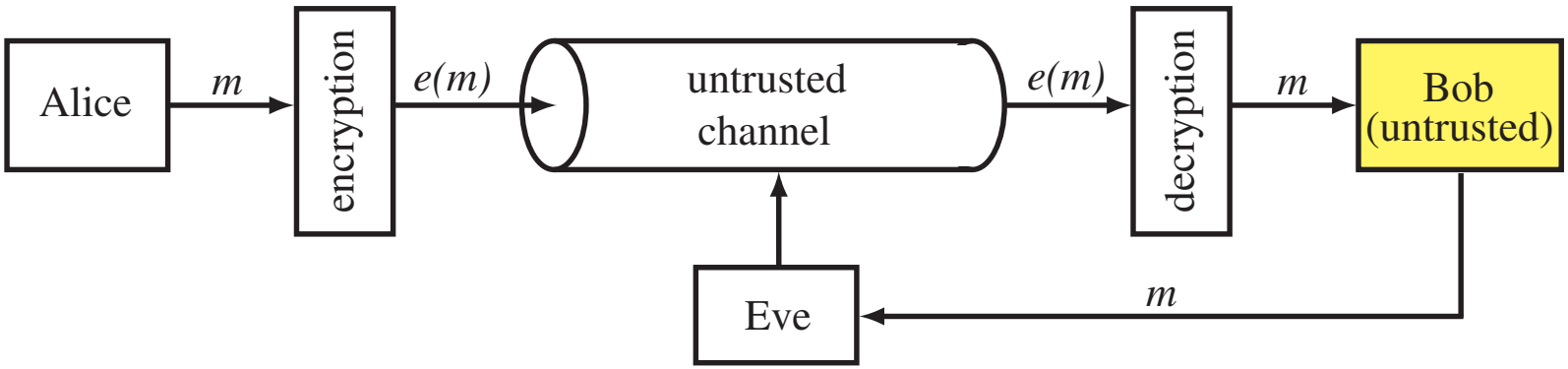

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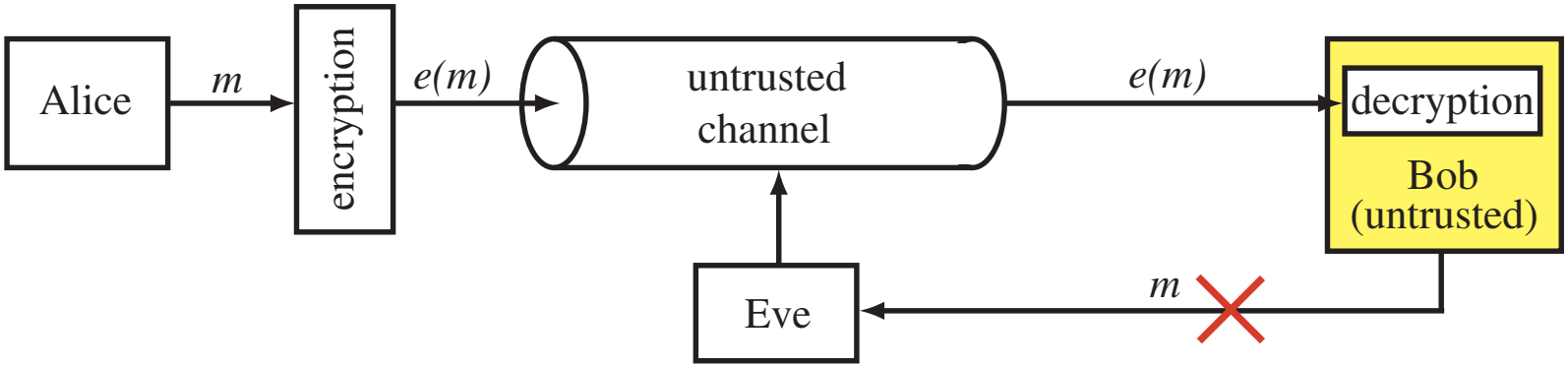

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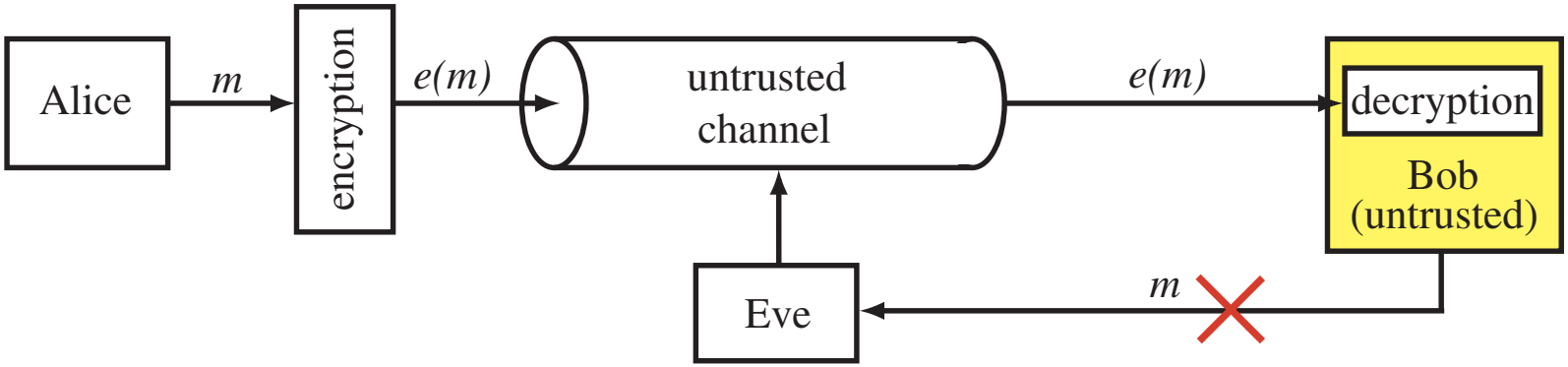

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  - Secure container on Bob's machine.
  - Properly "motivate" Bob to play by the rules.

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  Cons: due to cheating, hard to create win-win situations.

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- We will see that the structure of rights expression languages has a profound influence on the ability to do this.

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- In the future more intelligence will move into the core, perhaps including the ability to identify individual content objects within the network.

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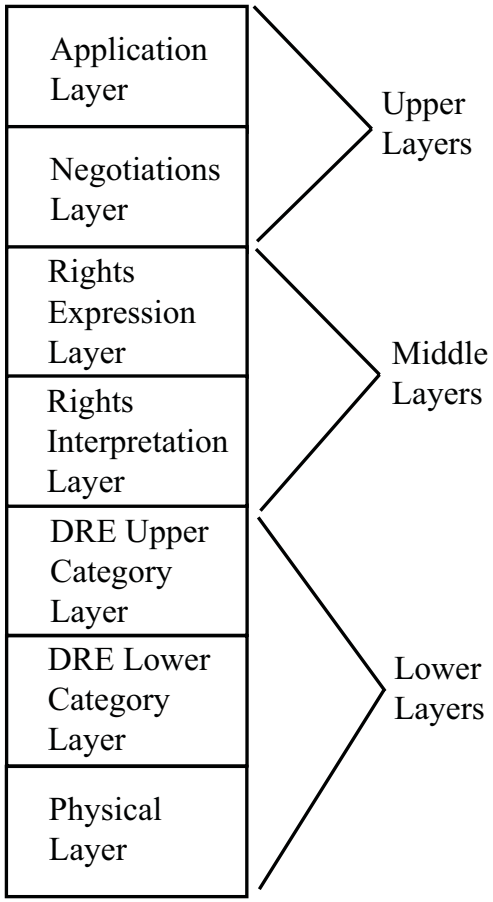
  - Designing for disconnections.
- TNA Architecture – we no longer depend upon an end point and the node that hosts it, but instead on a logical abstraction of the functionality that needs to be provided.

DRM Architectures

We have proposed an abstract layered architectural framework (similar to the OSI layers) for dealing with the problem of allowing multiple vendors to participate in the pipeline:



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- Various RELs have been proposed, some of them aimed at solving rights-related problems within a particular content industry.

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- METSRights (METSR) – Mainly used in academic and library-based environments providing content for education and research purposes, many of these are archival in nature. XML based.

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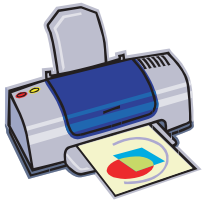

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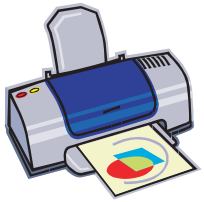

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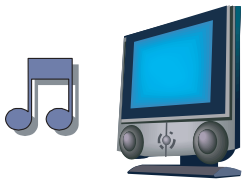

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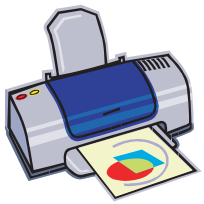

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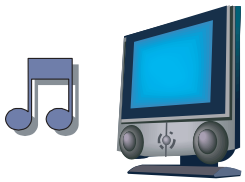

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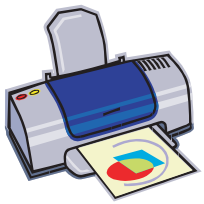

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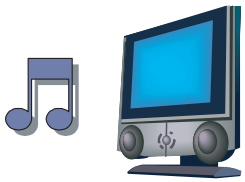

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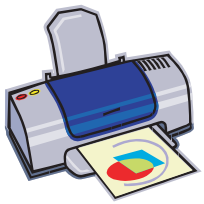

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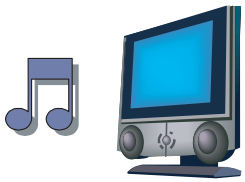

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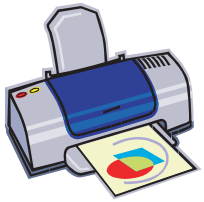

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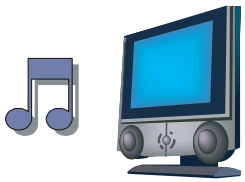

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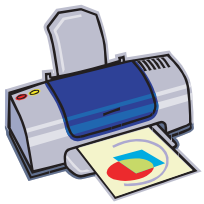

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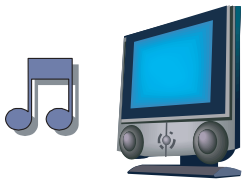

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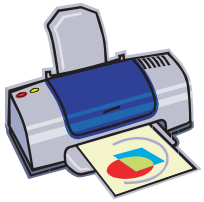

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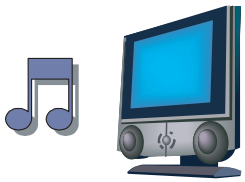

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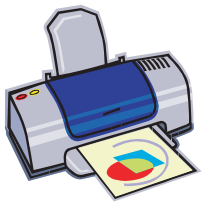

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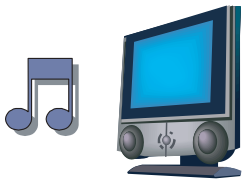

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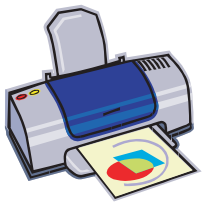

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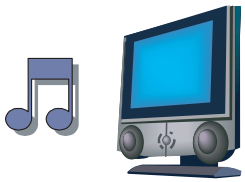

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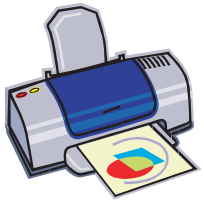

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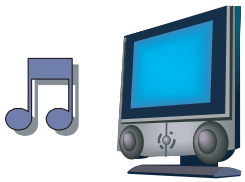

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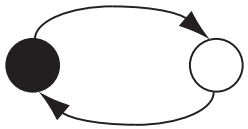

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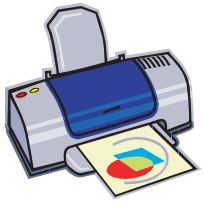

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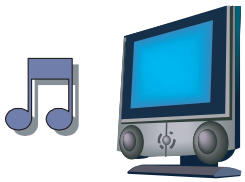

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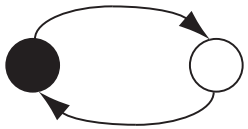

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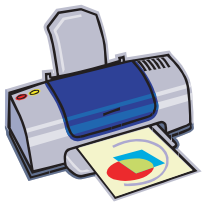

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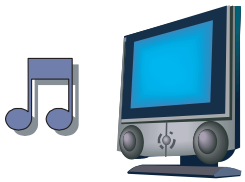

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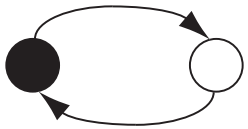

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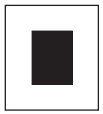

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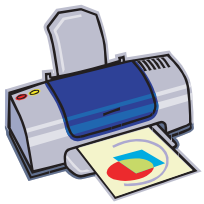

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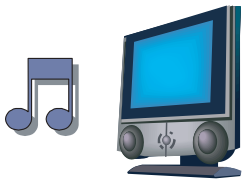

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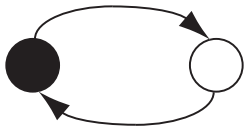

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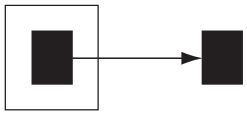

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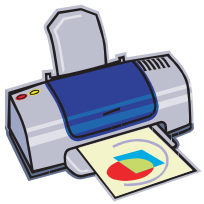

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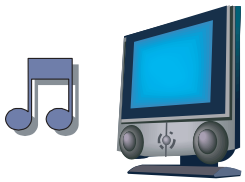

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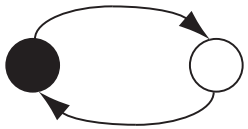

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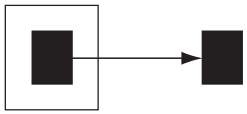

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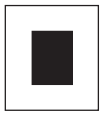

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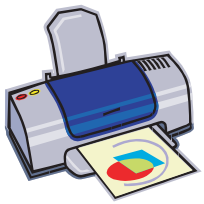

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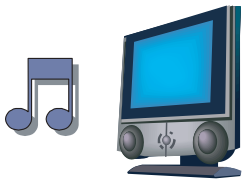

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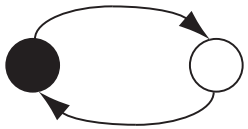

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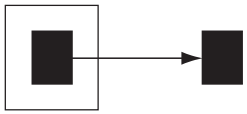

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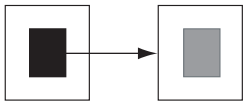

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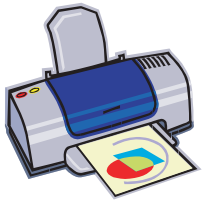

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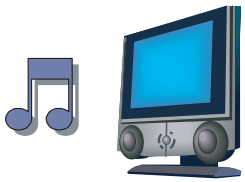

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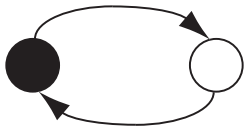

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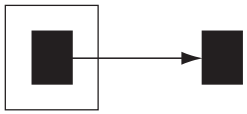

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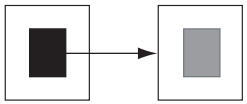

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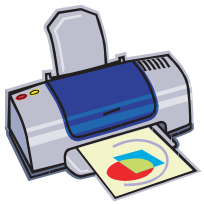

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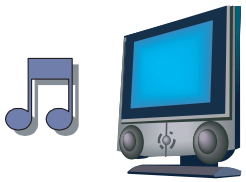

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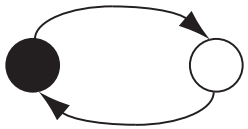

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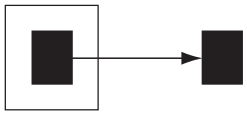

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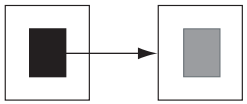

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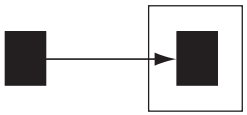

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An Analogy

Database	DRM
relational model	rights model

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Database	DRM
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tuple calculus	core REL (rights calculus)

An Analogy

Database	DRM
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- What would database management systems look like if they had evolved like DRM systems?

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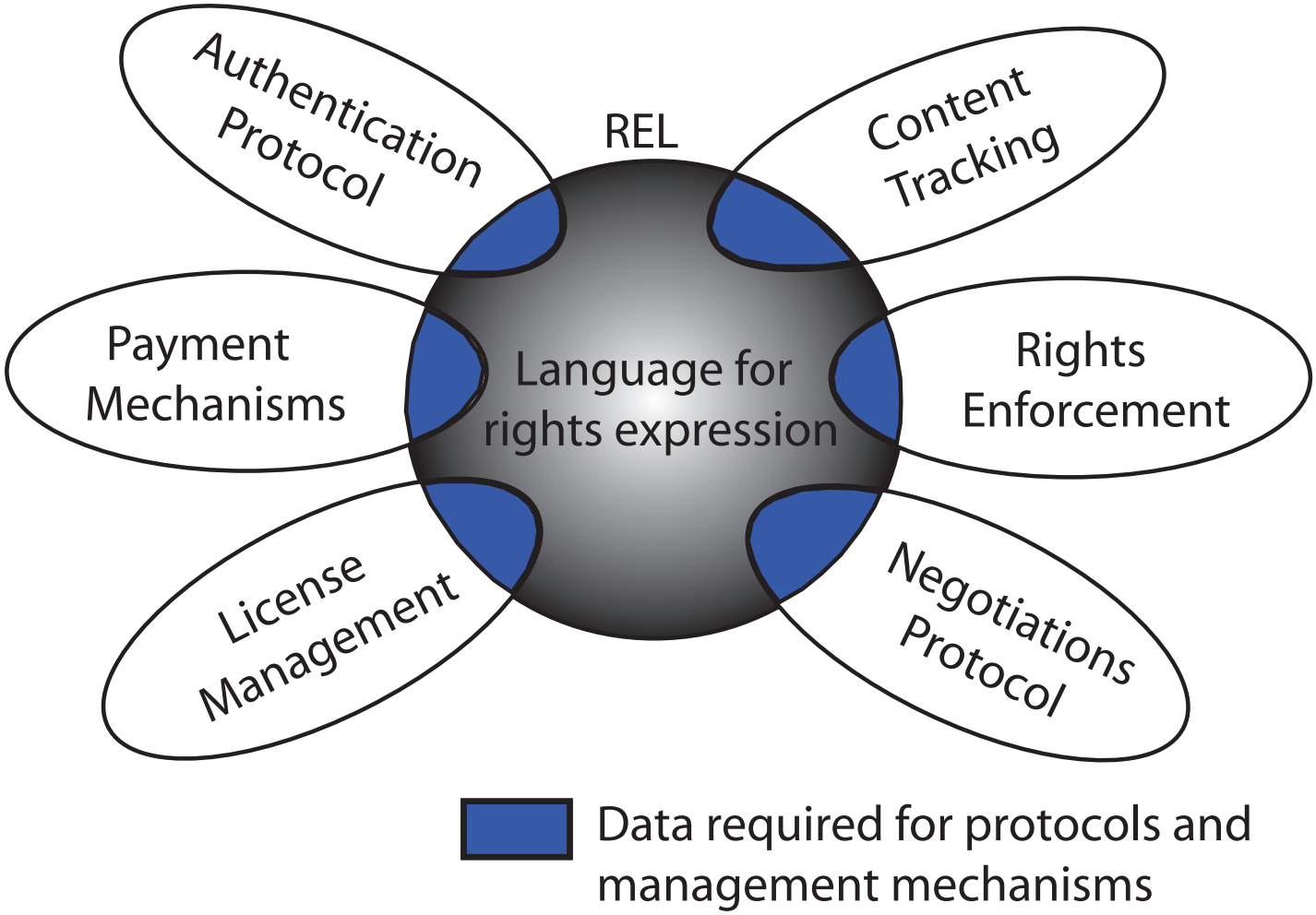
- With current RELs there is no clean separation between rights expression and DRM services — this makes it difficult to compose different DRM services.
  - A clean separation of rights from services is the key to creating interoperable DRM systems.
  - A refactoring of RELs is warranted.
  - The middleware of yesterday can become the fundamental network infrastructure of tomorrow, e.g., DNS, PKI

DRM Services – Current RELs



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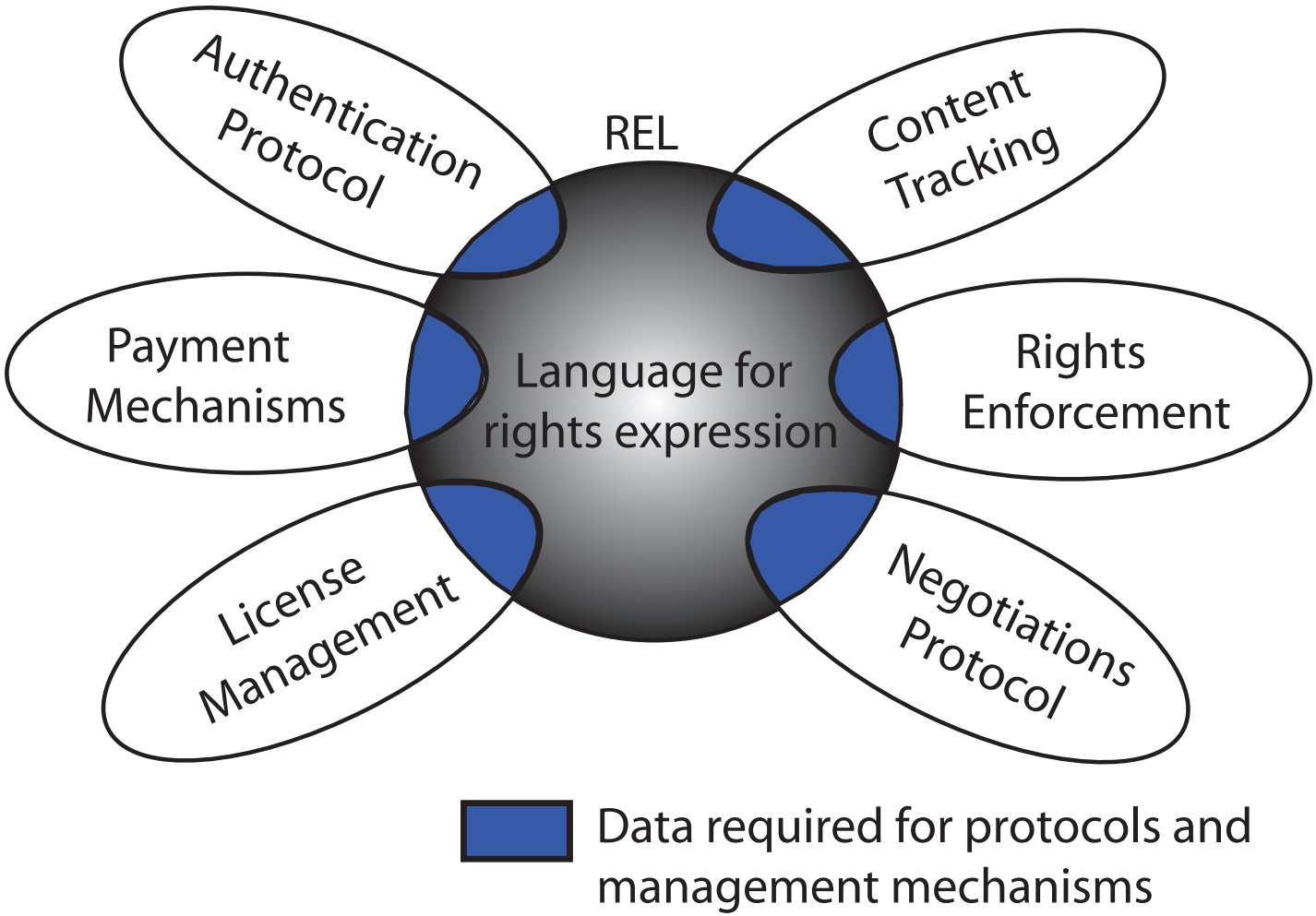
DRM Services – Simplified Core REL



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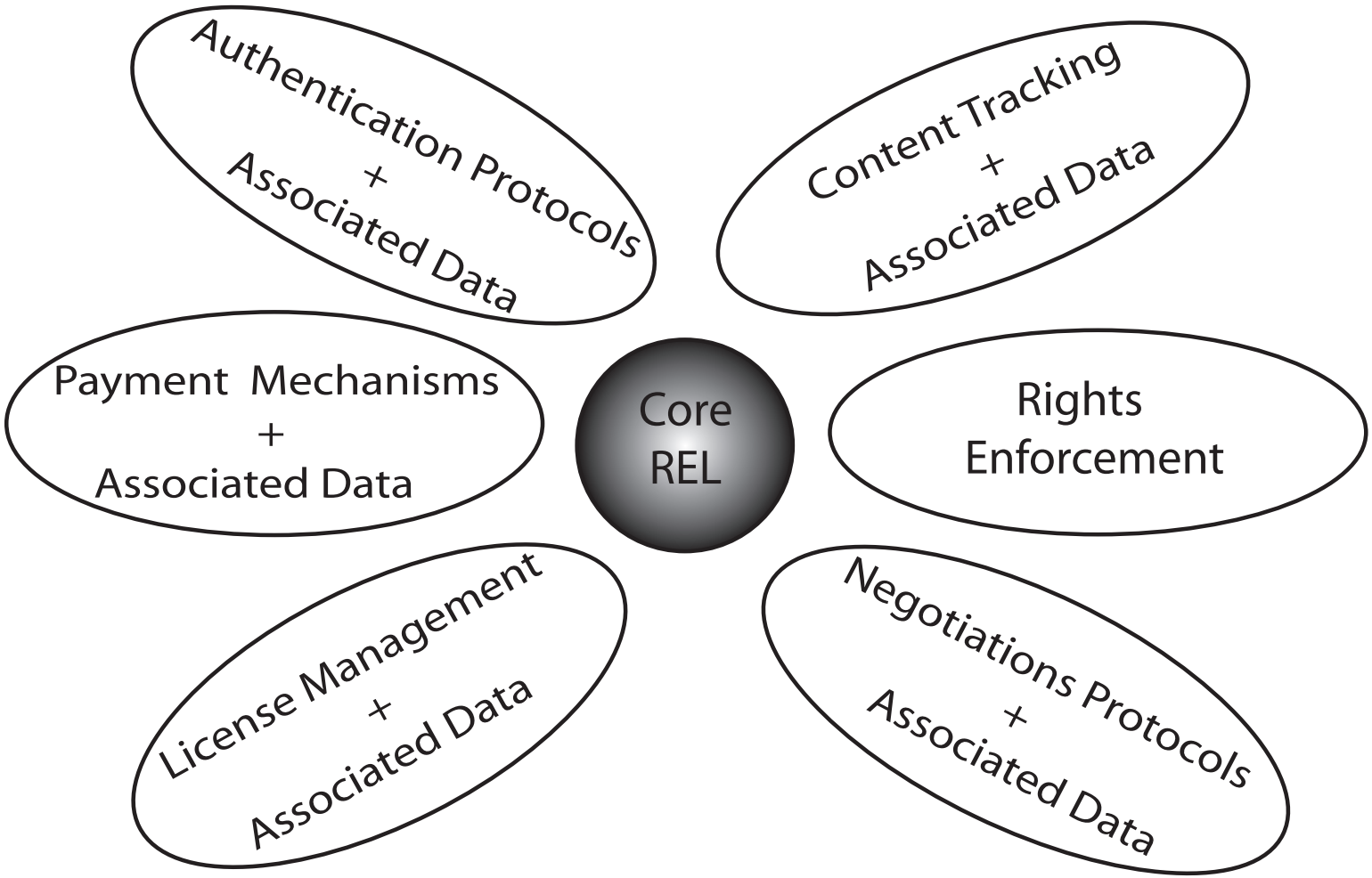
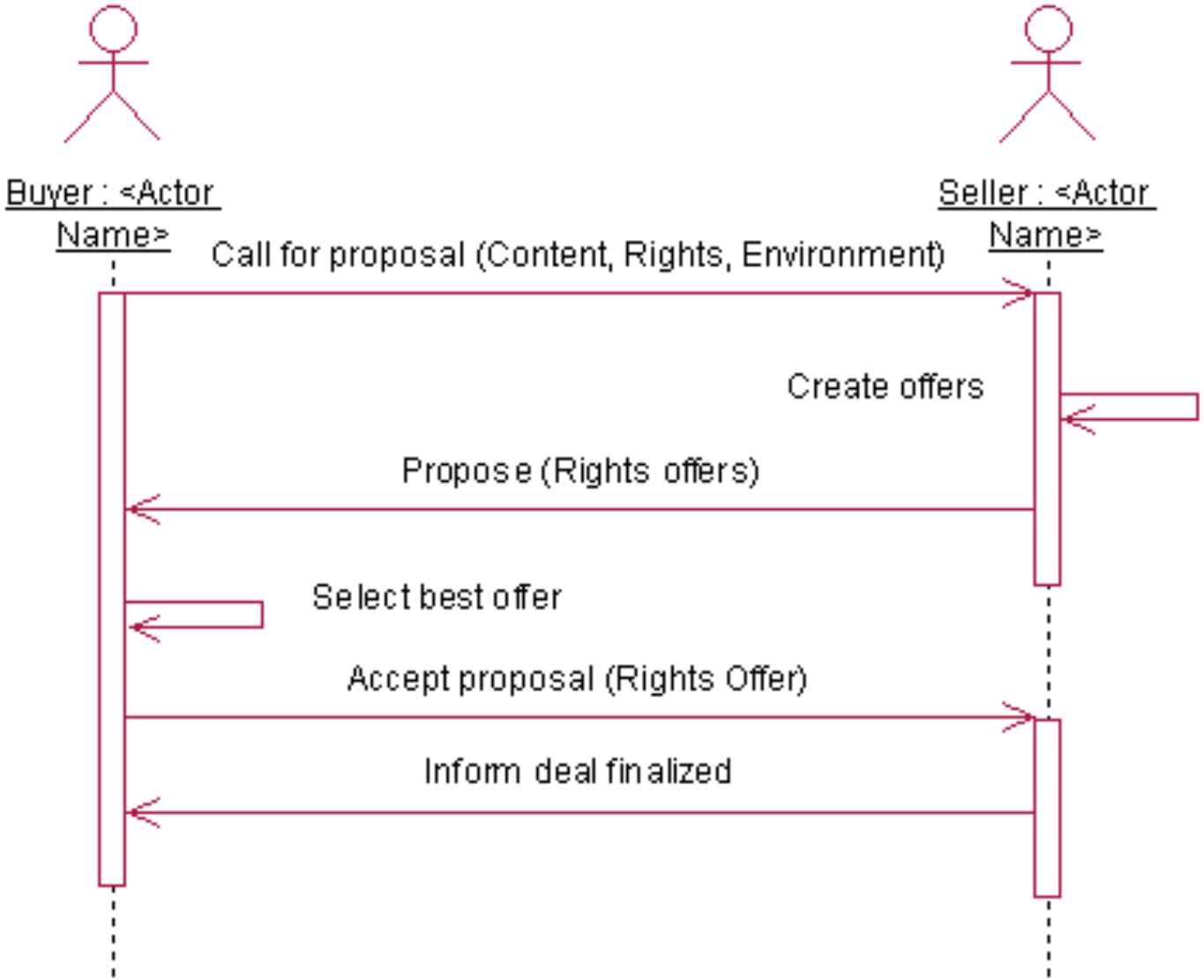


An Example DRM Scenario

Rights negotiations associated with a content purchase:



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  - Extension-based – include the semantics of the protocol and supporting data representation with the REL, and then develop a negotiations protocol that understands and uses the extended REL.
  - Middleware-based – the semantics of the protocol and supporting data are kept separate from the REL, and therefore the negotiations protocol is developed independent of the REL.

Protocol-integrated REL

The Buyer issues a call-for-proposal request:

```
<call-for-proposal>
    <environment> .......... </environment>
    <rights>
        <party> ............ </party>
        <content> .......... </content>
        <permission>.........</permission>
    </rights>
</call-for-proposal>
```

Protocol-integrated REL

The Seller analyze the call and creates a set of offers consistent with its policies:

```
<propose>
     <offer1>
          <rights>.....</rights>
     </offer1>
     <offer2>
          <rights>......</rights>
     </offer2>
</propose>
```

Protocol-integrated REL

The Buyer selects a particular offer by issuing an accept-proposal request informing the Seller which offer will be accepted:

```
<accept-proposal>
    <offer>
        <rights>......</rights>
    </offer>
</accept-proposal>
```

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- CNI is just one of the protocols specified by FIPA. Others, such as the Request Interaction Protocol and the Query Interaction Protocol would also be useful in DRM settings. Tags for these protocols would also need to be defined.

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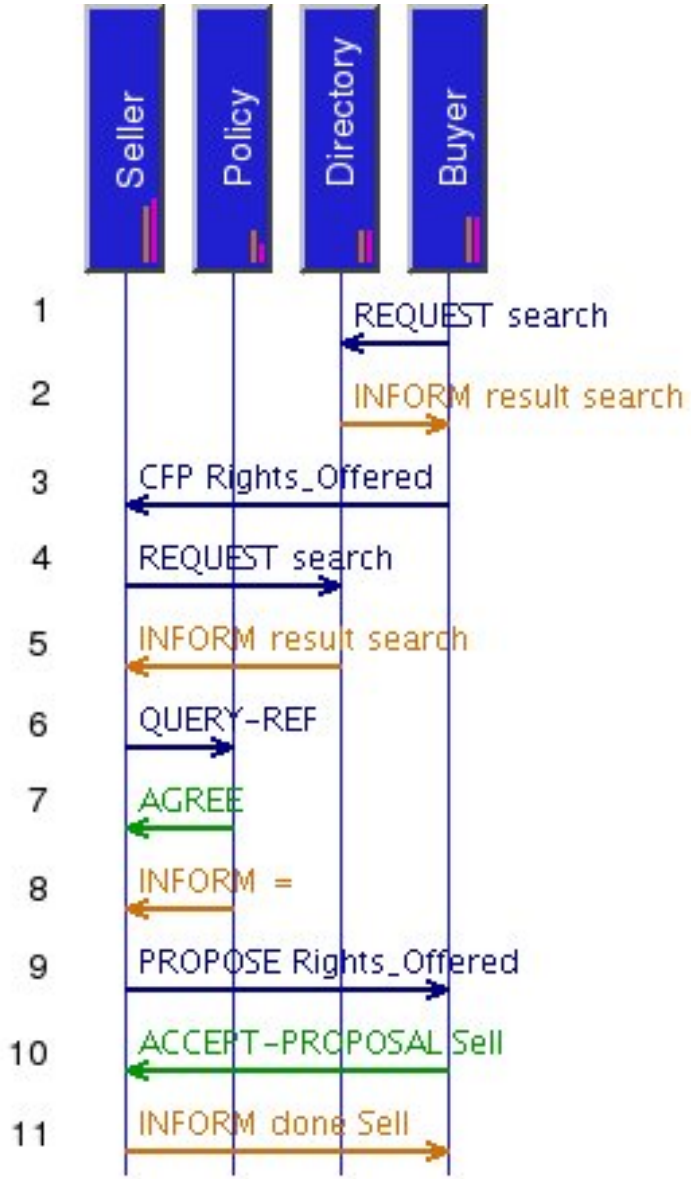
- We implemented this using an agent-based architecture.
  - Buyer agent
  - Seller agent
  - Policy agent

Middleware Approach



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- Thus, if the rights model is changed, and only the Policy agent would need to be changed.
- This makes is easy to package these DRM negotiations services as middleware.

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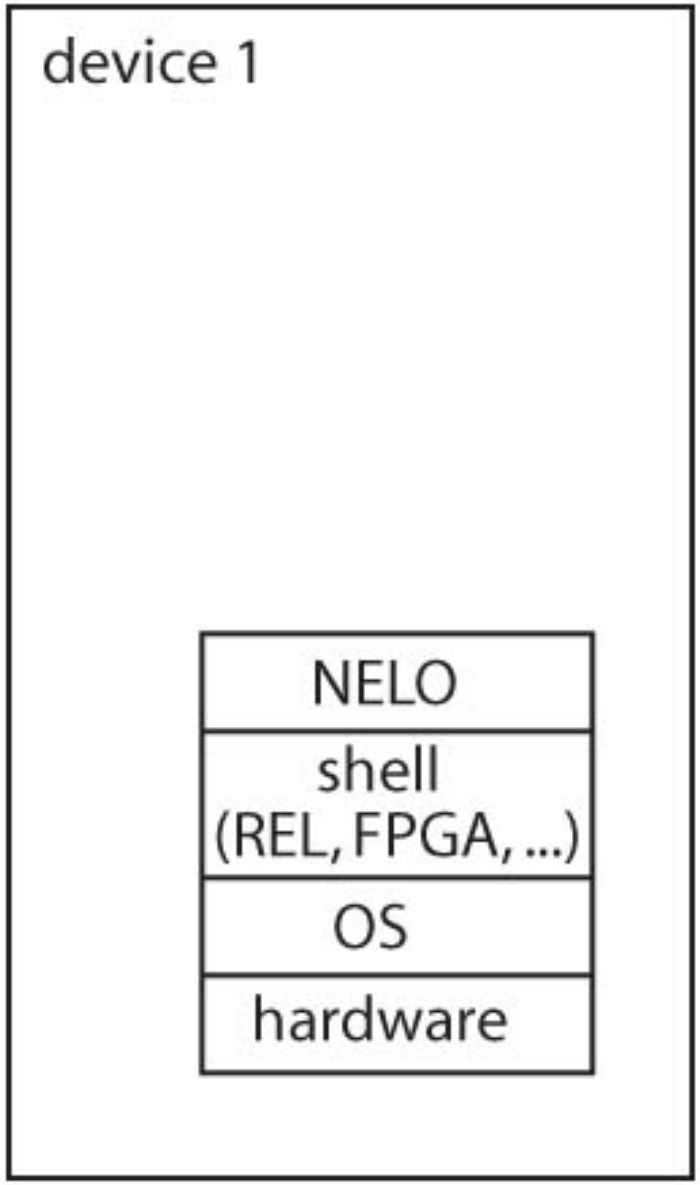
- The key ingredient involves separating rights expression from DRM services.
- The resulting simplified core REL greatly facilitates formal analysis.

Example



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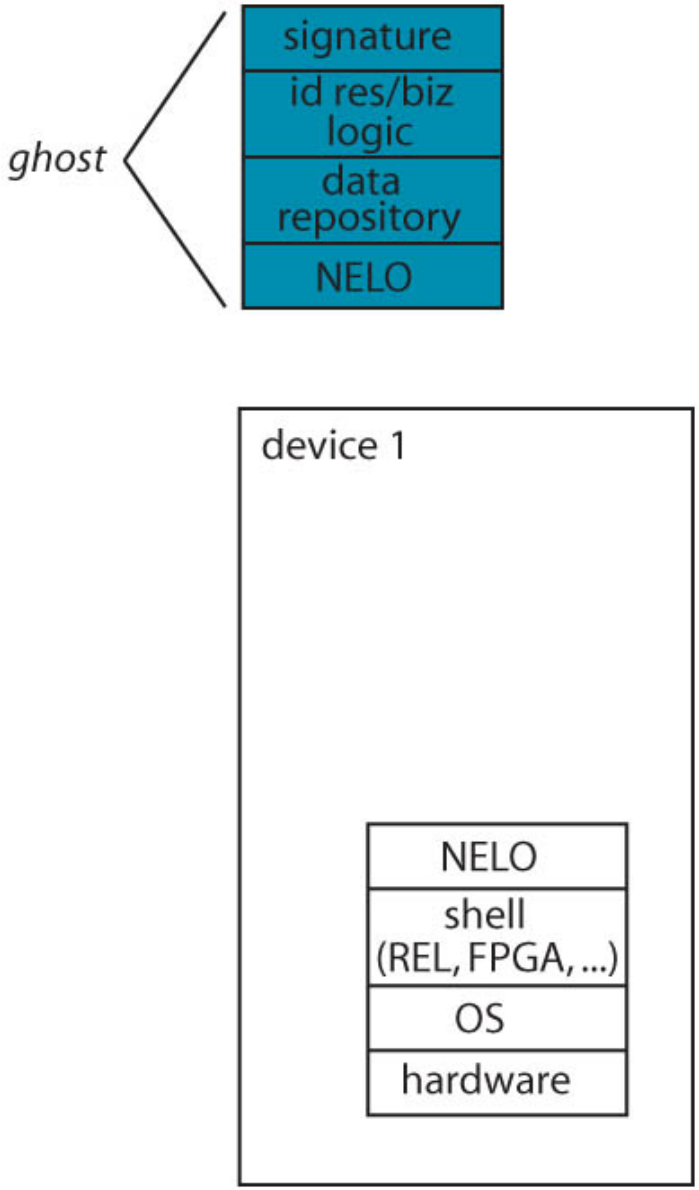
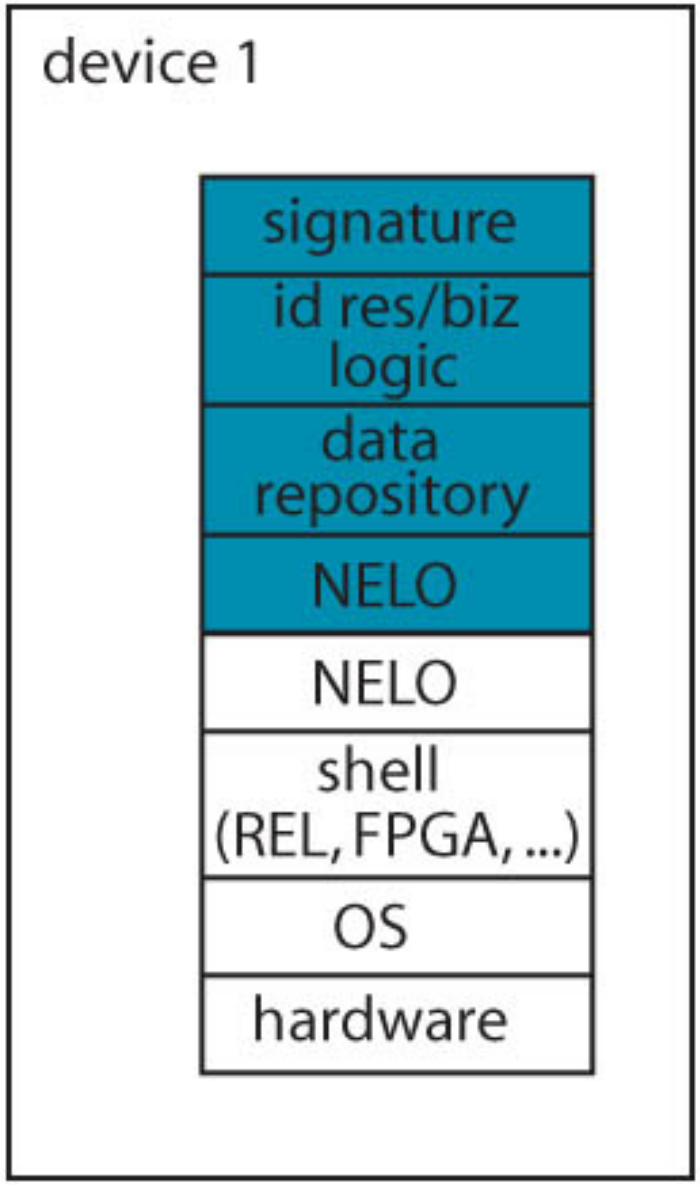

ghost
signature
id res/biz logic
data repository
NELO
device 1
NELO
shell (REL, FPGA, ...)
OS
hardware

Example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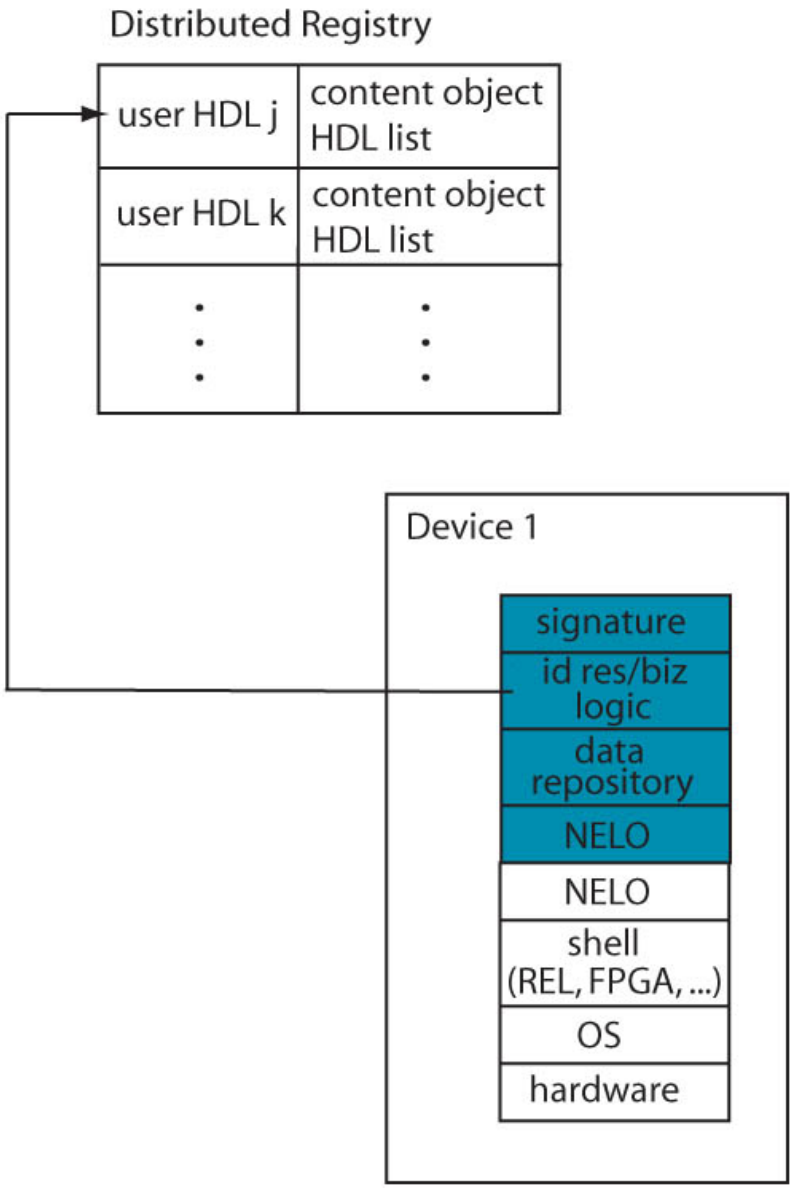
Distributed Registry
user HDL j
content object HDL list
user HDL k
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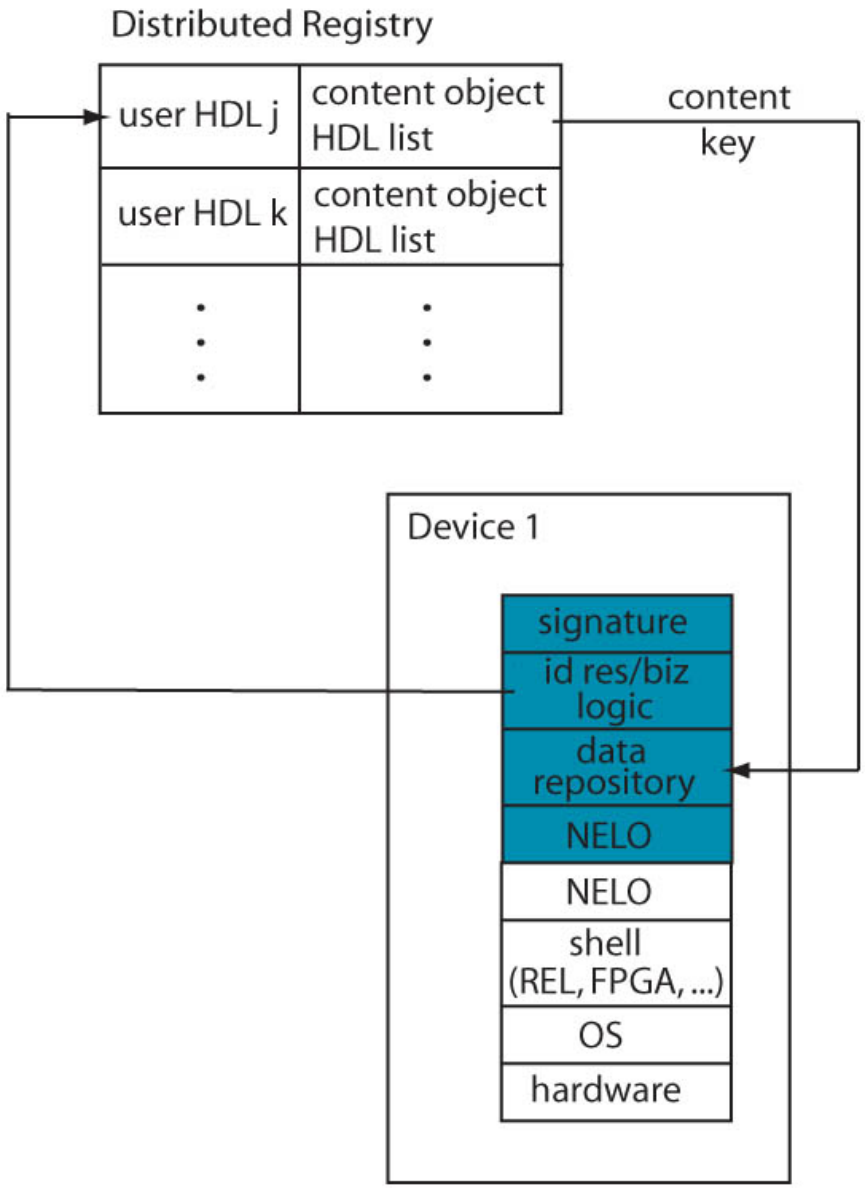
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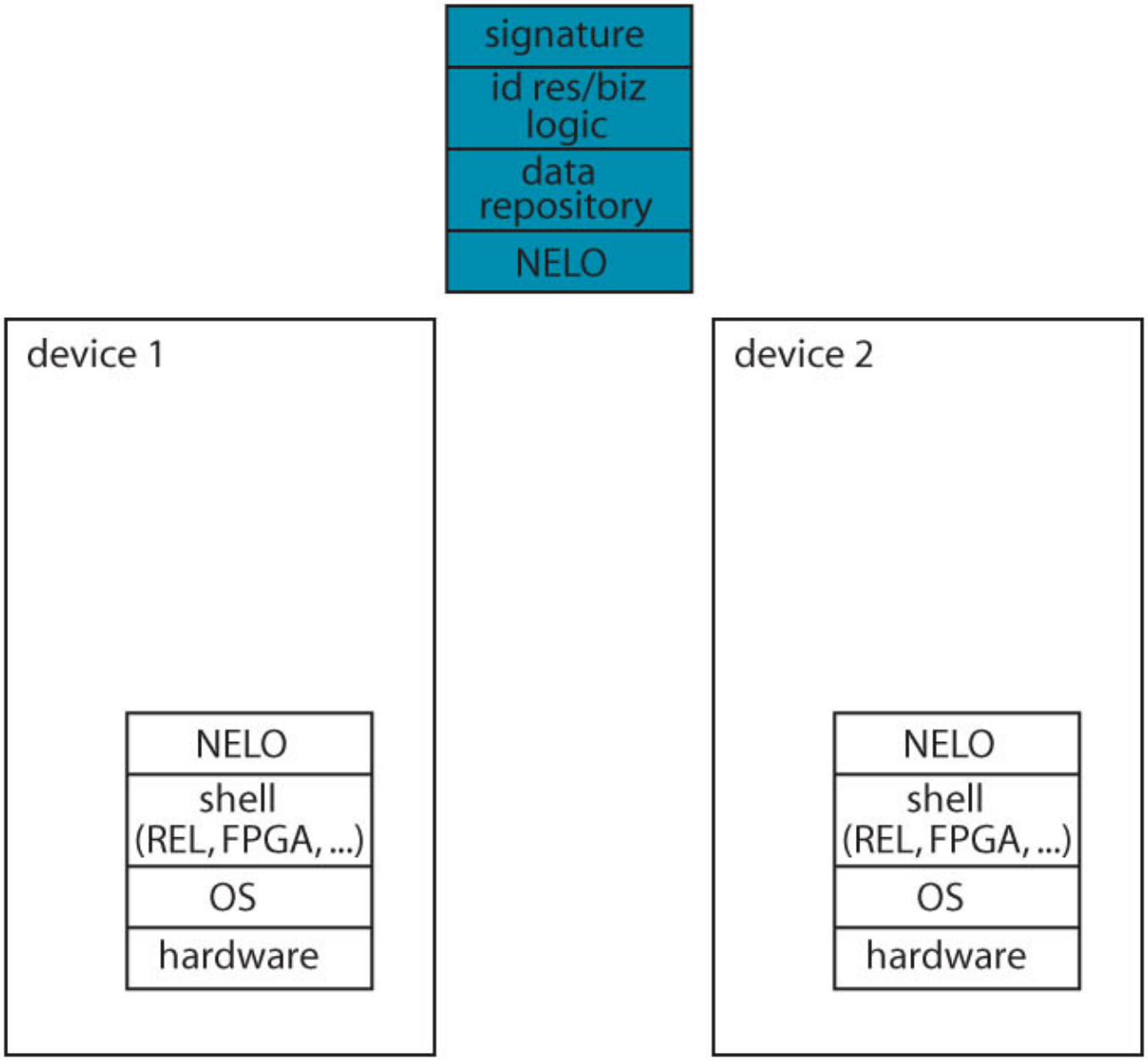
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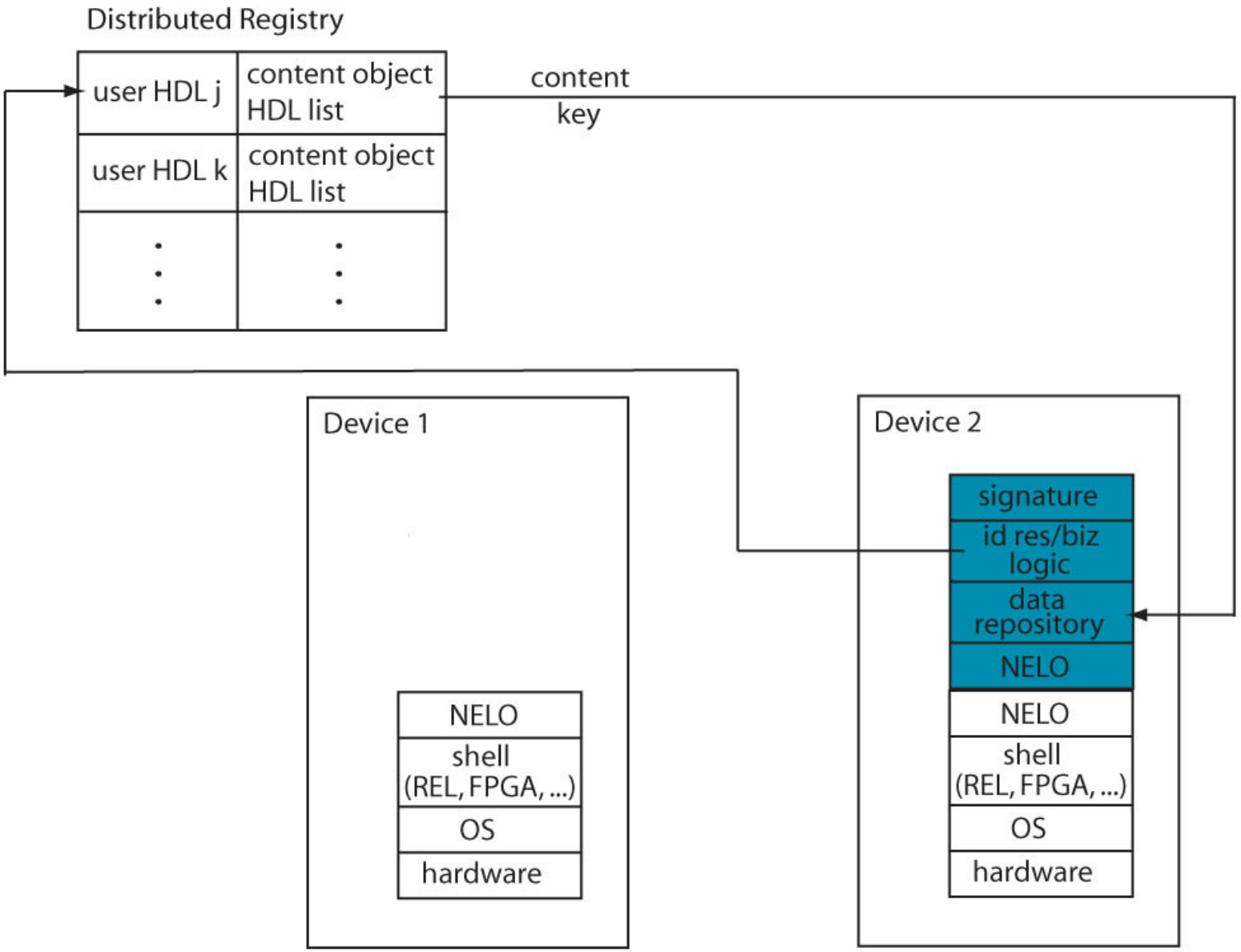
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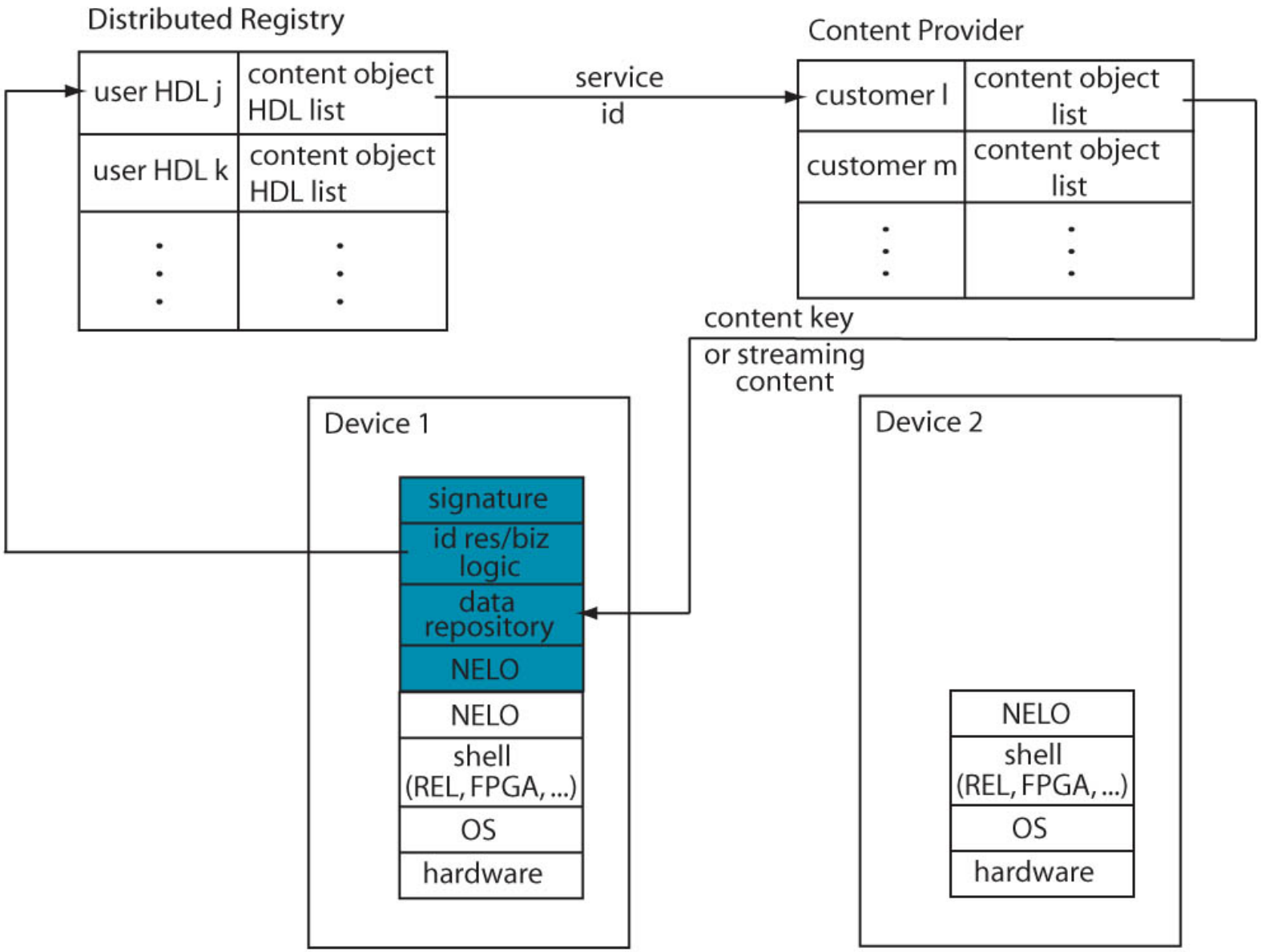
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service id
Content Provider
customer l
content object list
customer m
content object list
content key or streaming content
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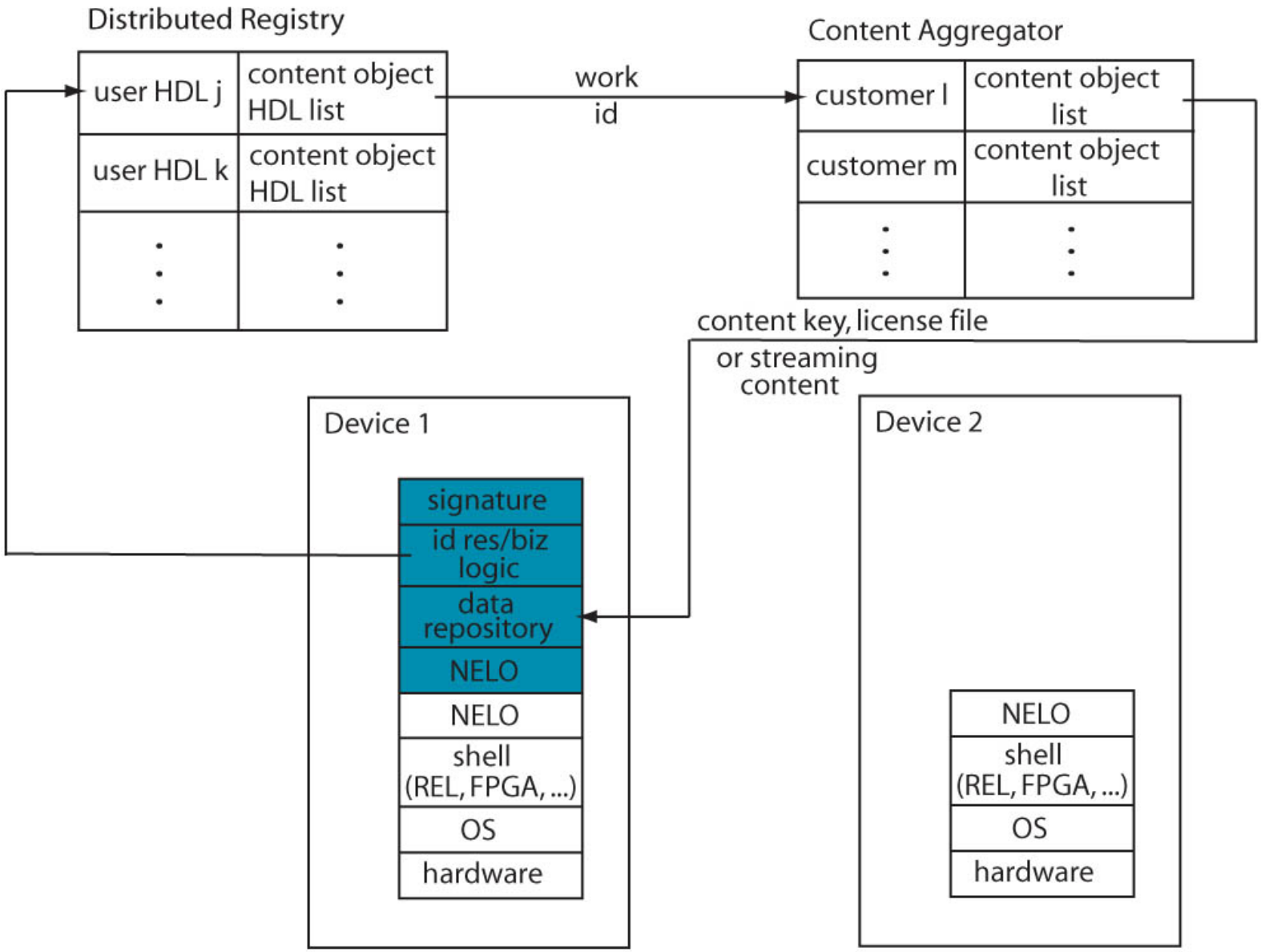
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