Ontológia nyelvek (Szemantikus Világhálótól ...)

XML
XML, DTD

Tudásreprezentáció
- Univerzális kifejező erő
- Szintaktikai interoperabilitás
- Szemantikai interoperabilitás

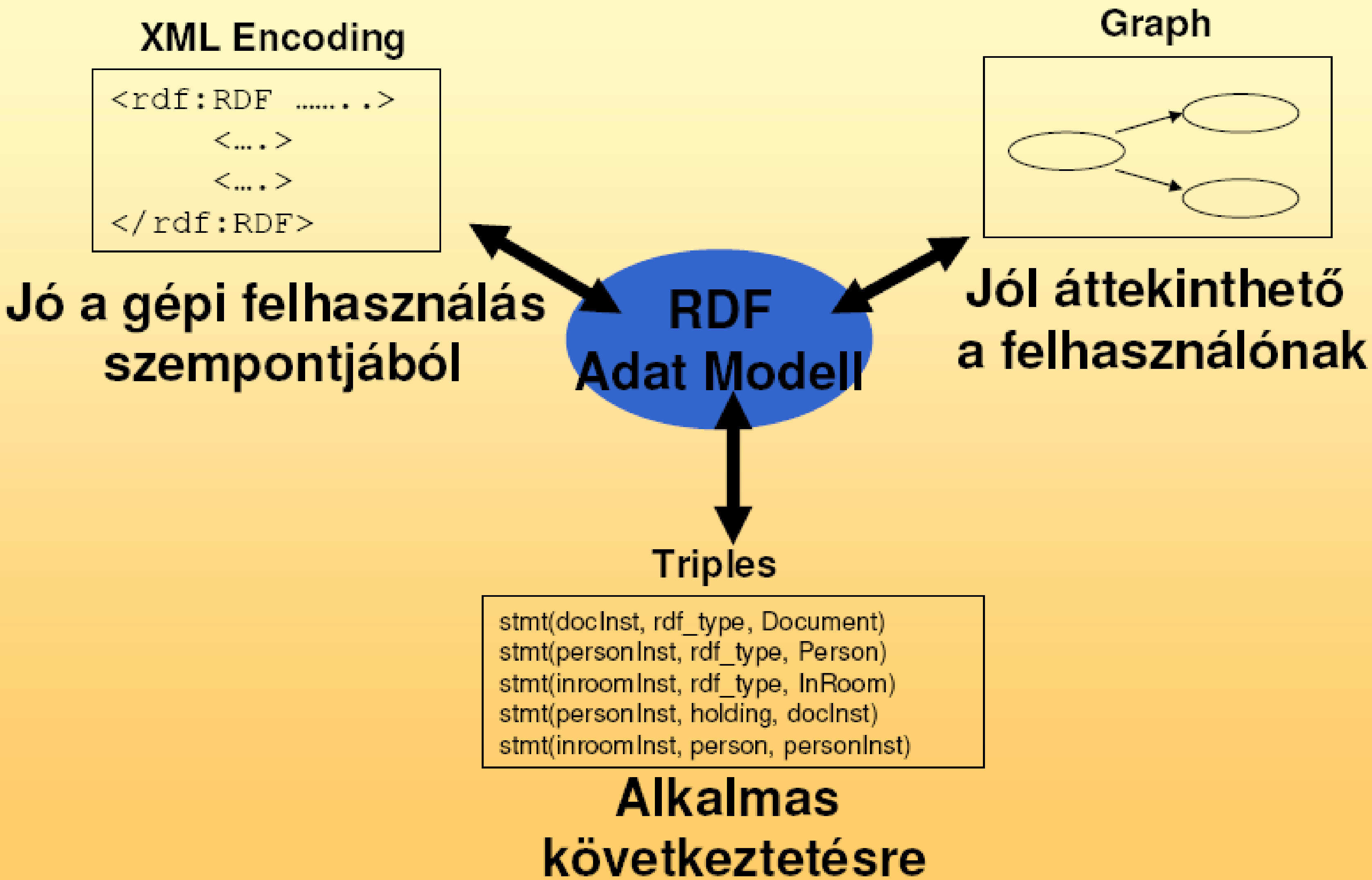
RDF

RDFS

DAML+OIL

OWL
- ***OWL-Lite***
- ***OWL-DL***
- ***OWL-Full***
- **BayesOWL**
- **f-DL-Lite**
- **fL-SHIf(D)**
- **... ... ...**

RDF az első SzW nyelv



RDF: Resource Description Framework

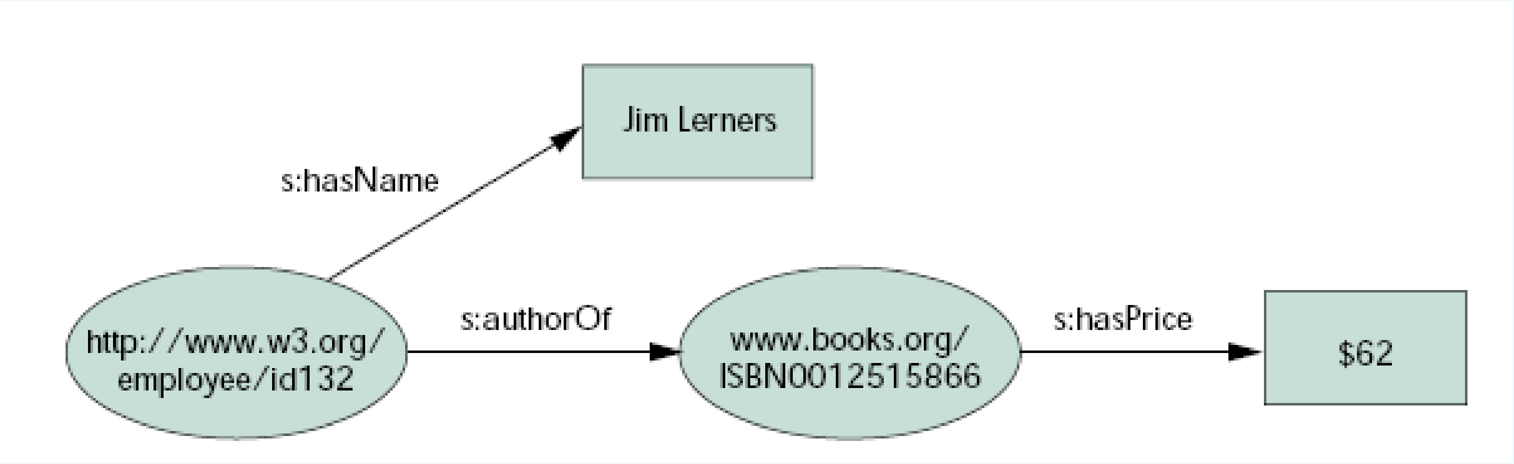
RDF kifejezések: hármasok

<subject> <predicate> <object>
<predicate>(<subject>,<object>)

<URI> <URI> <URI>
<URI> <URI> <quoted string>

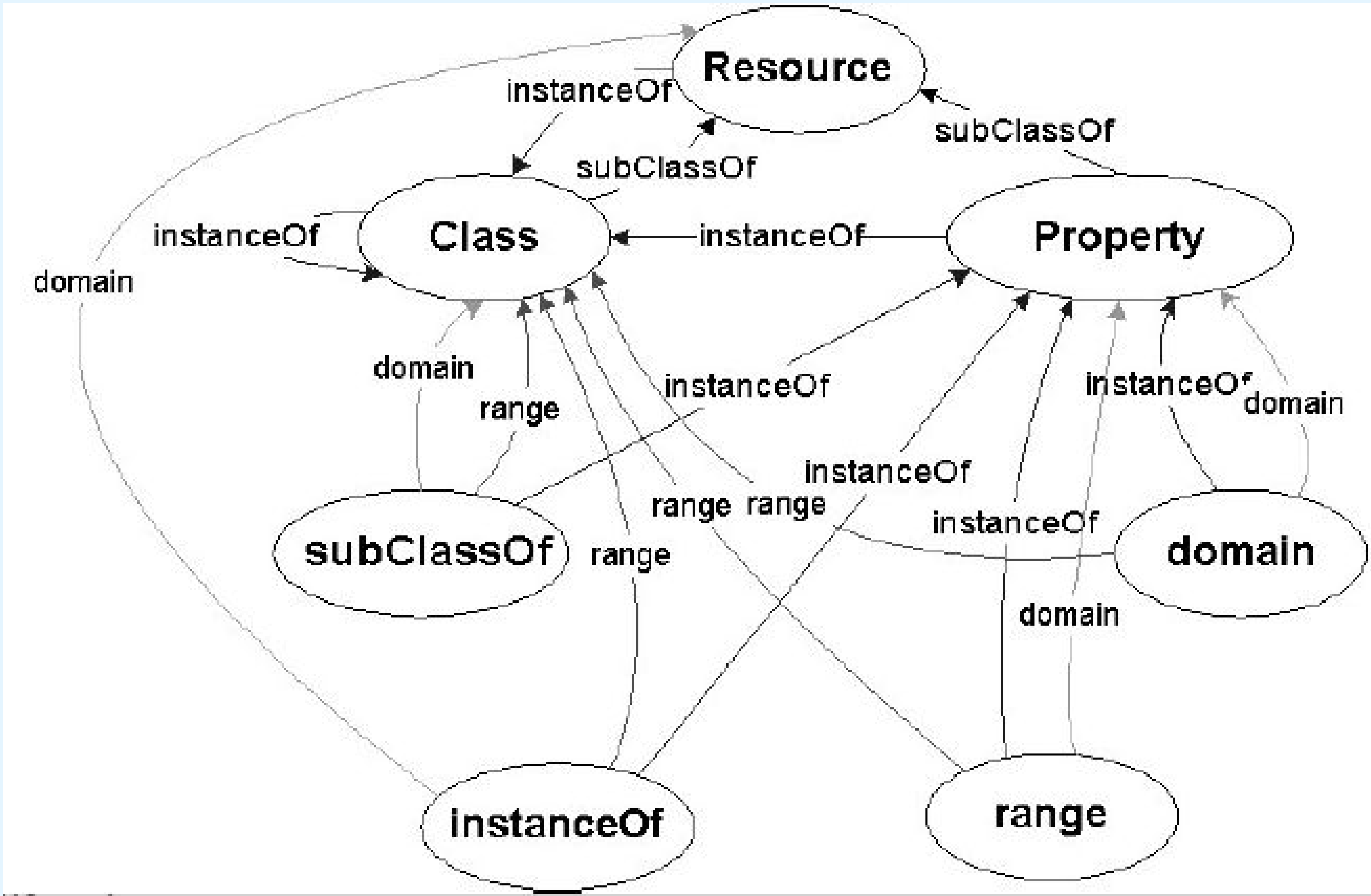
Könnyen transzformálhatóak a logika számára
Jól tárolhatóak adatbázisban

hasName
(‘http://www.w3.org/employee/id1321’,
”Jim Lerners”)
authorOf
(‘http://www.w3.org/employee/id1321’,
’http://www.books.org/ISBN0012515866’)
hasPrice
(‘http://www.books.org/ISBN0012515866’,
“$62”).

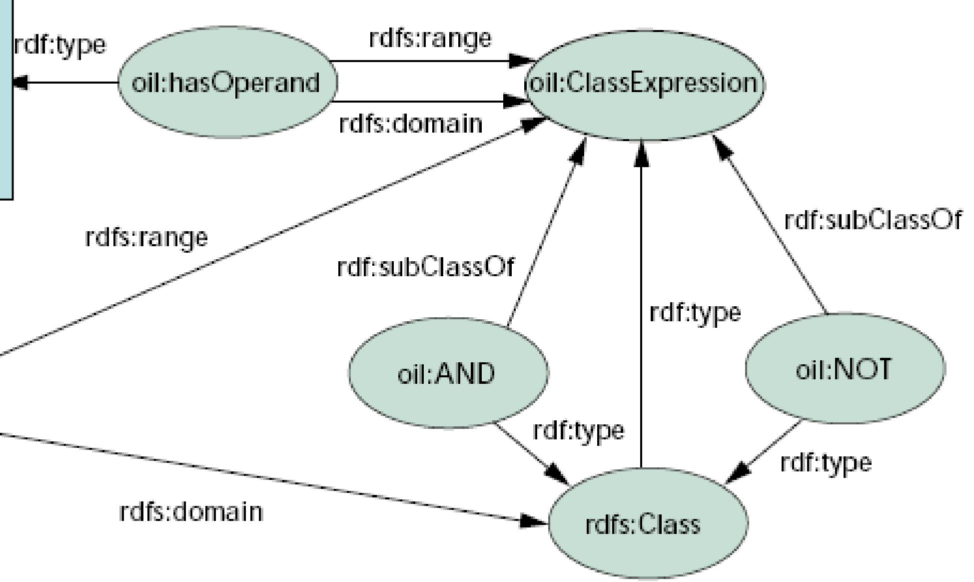


Forrás Leíró Keret Sémák
Resource Description Framework Schema (RDFS)

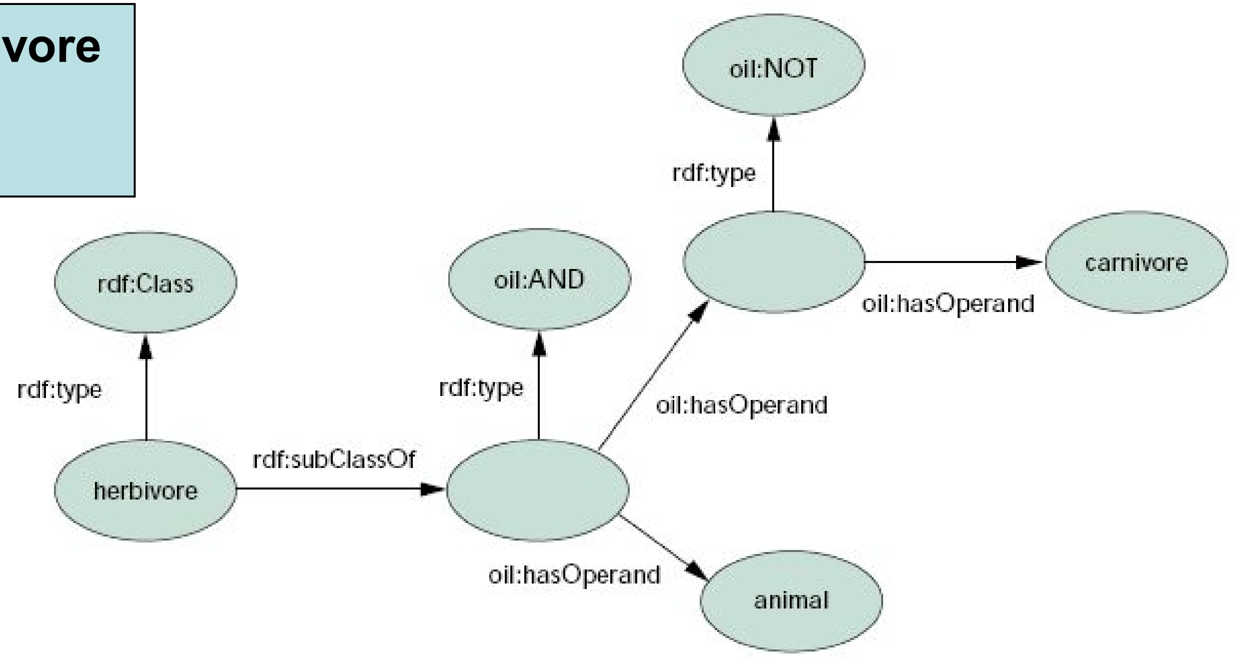
mechanizmus – alap tipusok RDF modellek számára
pl. Class, subPropertyOf, subClassOf, ...



OIL: Ontology Inference Layer
egy nyelv jobb
kifejező erővel



class-def defined herbivore
subclass-of animal,
NOT carnivore

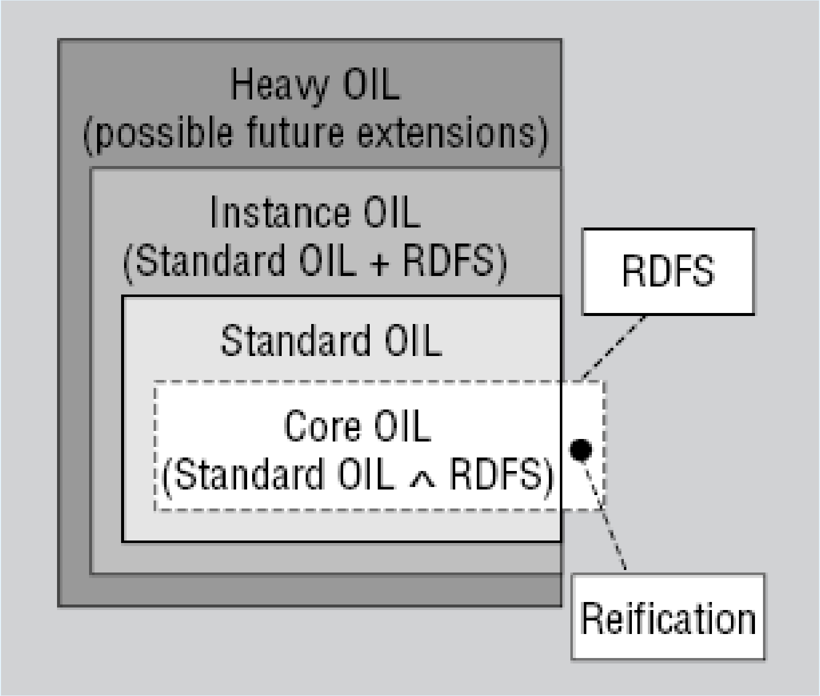


Semantics via translation to $\mathcal{SHIQ}$ DL:

OIL	Equivalent $\mathcal{SHIQ}$
slot-def part-of	
subslot-of structural-relation	% part-of $\sqsubseteq$ structural-relation
inverse has-part	% has-part $\doteq$ part-of^{-}
properties transitive	% part-of $\in \mathbf{R}_{+}$
class-def defined herbivore	% herbivore $\doteq$
subclass-of animal	% animal $\sqcap$
slot-constraint eats	
value-type plant **OR**	% $\forall$eats.(plant $\sqcup$
slot-constraint part-of	
has-value plant	% $\exists$part-of.plant) $\sqcap$
min-cardinality 2 vegetable	% $\geqslant 2.eats$vegetable
disjoint herbivore carnivore	% herbivore $\sqsubseteq$ $\neg$carnivore

DAML (DARPA Agent Markup Language) és **OIL**
US DAML kezdeményezés, RDFS alapú ontológia nyelv
Joint US/EU Committee on Agent Markup Languages
Cél: W3C szabvány

Web integration
Frame-based systems
Description logics



DAML+OIL

axiómái: Knowledge Interchange Format (KIF)
szemantika: FOL

DAML+OIL constructors

Constructor	DL Syntax	Example
intersectionOf	$C_1 \sqcap \ldots \sqcap C_n$	Human $\sqcap$ Male
unionOf	$C_1 \sqcup \ldots \sqcup C_n$	Doctor $\sqcup$ Lawyer
complementOf	$\neg C$	$\neg$Male
oneOf	$\{x_1 \ldots x_n\}$	{john, mary}
toClass	$\forall P.C$	$\forall$hasChild.Doctor
hasClass	$\exists r.C$	$\exists$hasChild.Lawyer
hasValue	$\exists r.\{x\}$	$\exists$citizenOf.{USA}
minCardinalityQ	$(\geqslant n\ r.C)$	($\geqslant$ 2 hasChild.Lawyer)
maxCardinalityQ	$(\leqslant n\ r.C)$	($\leqslant$ 1 hasChild.Male)
inverseOf	r^-	hasChild$^-$

DAML+OIL axioms

Axiom	DL Syntax	Example
subClassOf	$C_1 \sqsubseteq C_2$	Human $\sqsubseteq$ Animal $\sqcap$ Biped
sameClassAs	$C_1 \equiv C_2$	Man $\equiv$ Human $\sqcap$ Male
subPropertyOf	$P_1 \sqsubseteq P_2$	hasDaughter $\sqsubseteq$ hasChild
samePropertyAs	$P_1 \equiv P_2$	cost $\equiv$ price
disjointWith	$C_1 \sqsubseteq \neg C_2$	Male $\sqsubseteq$ $\neg$Female
sameIndividualAs	$\{x_1\} \equiv \{x_2\}$	{President_Bush} $\equiv$ {G_W_Bush}
differentIndividualFrom	$\{x_1\} \sqsubseteq \neg\{x_2\}$	{john} $\sqsubseteq$ $\neg${peter}
transitiveProperty	$P \in \mathbf{R}_+$	hasAncestor$^+$ $\in \mathbf{R}_+$
uniqueProperty	$\top \sqsubseteq (\leqslant 1\ P.\top)$	$\top \sqsubseteq$ ($\leqslant$ 1 hasMother.$\top$)
unambiguousProperty	$\top \sqsubseteq (\leqslant 1\ P^-.\top)$	$\top \sqsubseteq$ ($\leqslant$ 1 isMotherOf$^-$.$\top$)

OWL (Web Ontology Language)

constructor name	OWL syntax	DL syntax	semantics
conjunction	intersectionOf	$C \sqcap D$	$C^I \cap D^I$
existential restriction	someValuesFrom	$\exists r.C$	$\{x \in \Delta \mid \exists y : (x,y) \in r^I \wedge y \in C^I\}$
value restriction	allValuesFrom	$\forall r.C$	$\{x \in \Delta \mid \forall y : (x,y) \in r^I \rightarrow y \in C^I\}$
negation	complementOf	$\neg C$	$\Delta \setminus C^I$
disjunction	unionOf	$C \sqcup D$	$C^I \cup D^I$

OWL **Web Ontology Language**
W3C ajánlás 8/18/2003
RDFS kiterjesztése
Három változat
– OWL Lite
– OWL DL
– OWL Full

OWL Property leírások
- TransitiveProperty
- SymmetricProperty
- FunctionalProperty
- inverseOf
- InverseFunctionalProperty

OWL Property korlátozások
- allValuesFrom
- someValuesFrom
- minCardinality
- maxCardinality
- cardinality
- hasValue (OWL DL)

Eredeti OWL Web Ontology Language szintaxisa:
- normatív csere szintaktika: RDF/XML
- un. absztrakt szintaktika OWL DL számára
- XML szintaktika

```
Class: Person
   Annotations: rdfs:label "Person"@en
   SubClassOf: hasAge exactly 1
       and hasGender exactly 1
       and hasGender only {female , male}

Class: Man SubClassOf: Person
   EquivalentTo: Person that hasGender value male

Class: Parent SubClassOf: Person
   EquivalentTo: Person that hasChild min 1 Person

Class: Teenager
   EquivalentTo: Person that hasAge some integer[>= 13 , < 20]
```

Ontológiák

Meta-Ontológiák: RDF, RDFS, DAML+OIL, OWL

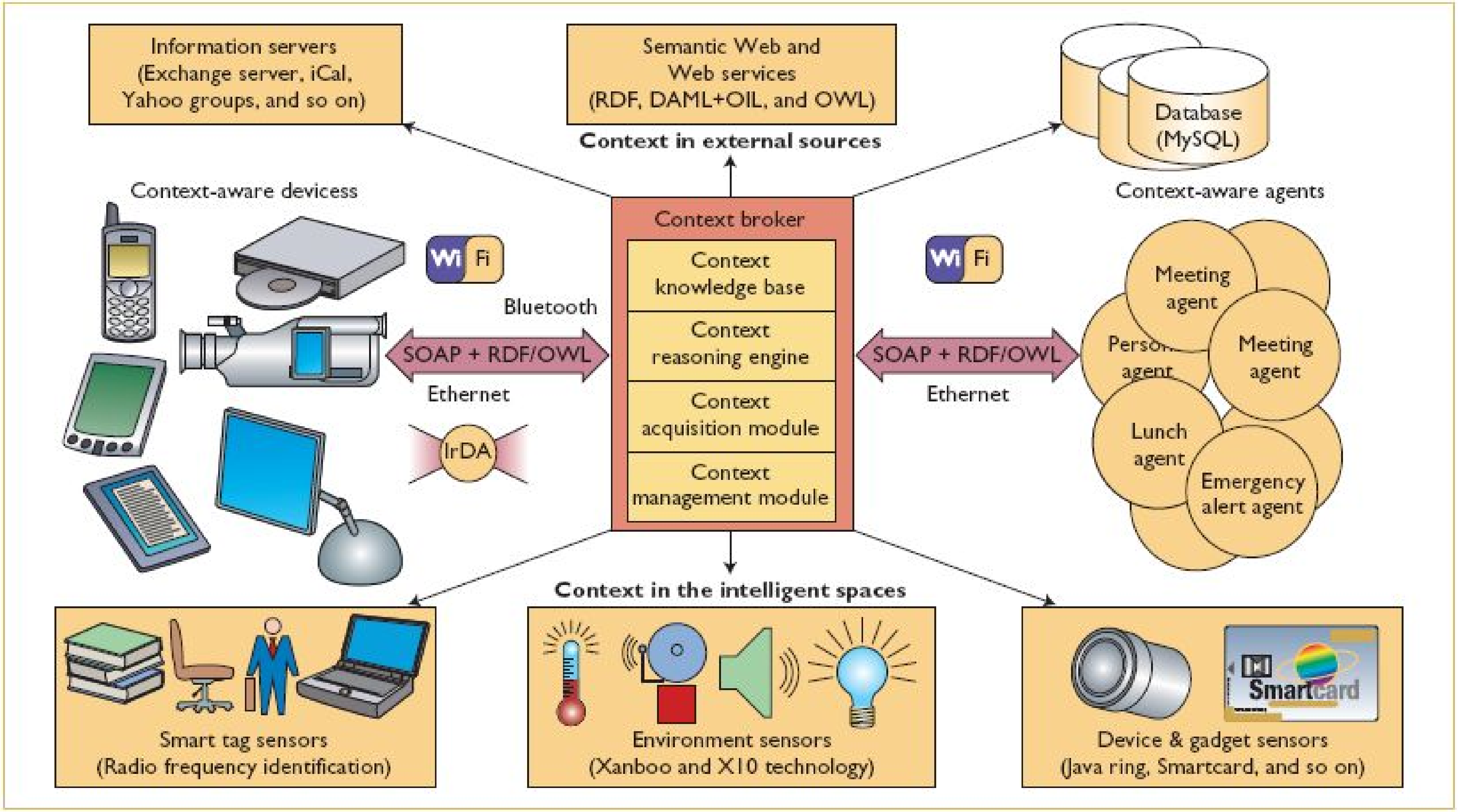
Átfogó Felső Ontológiák (Comprehensive Upper Ontologies):
Cyc,WordNet, OntoSem, IEEE's Standard Upper Ontology (SUO)

Szisztematikus Domén Specifikus Ontológiák: jogi, genetikus, vegyi,
bio, térbeli, ..., orvosi ontológiák

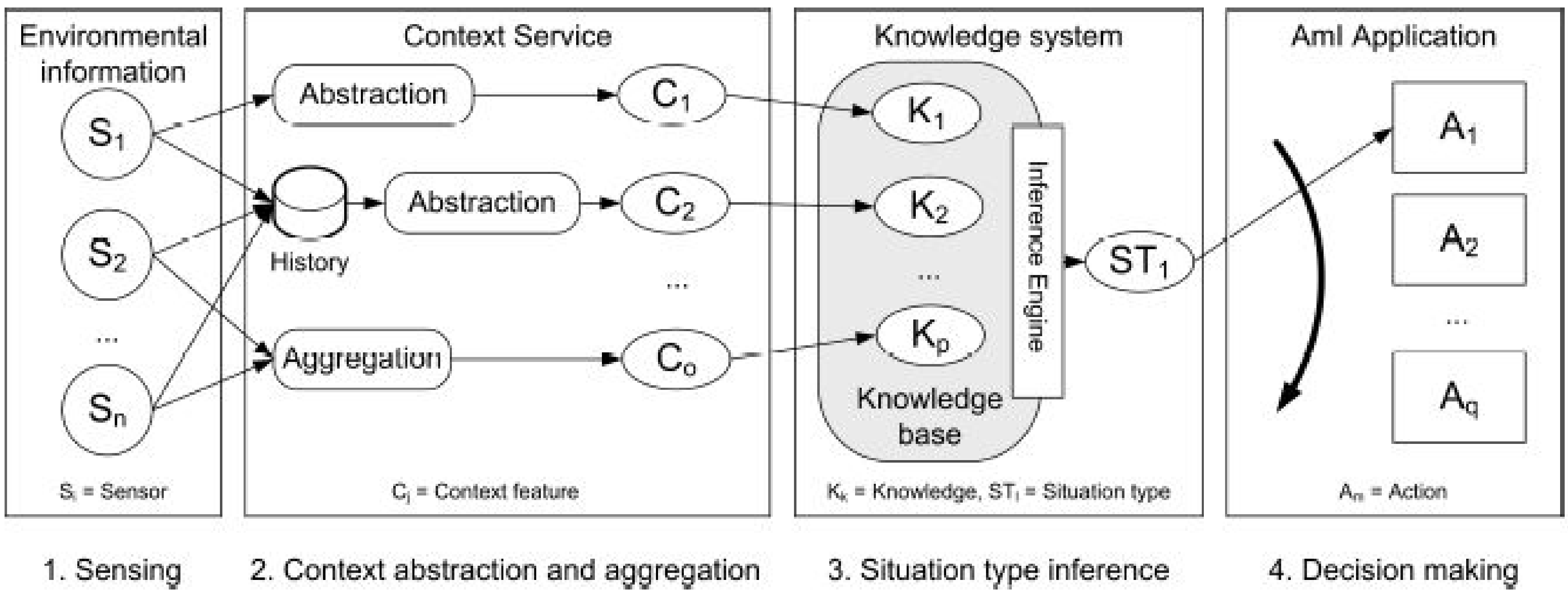
Egyszerű Speciálizált Ontológiák:
Dublin Core, Friend-Of-A-Friend (FOAF), Inference Web ontology,
Creative Commons, FIPA Device Ontology, ...

Ontológia Szerkesztők + következtetők
Protégé, KAON, …
....
RACERPRO , FACT++, PELLET, …

The Context Broker Architecture (Cobra).



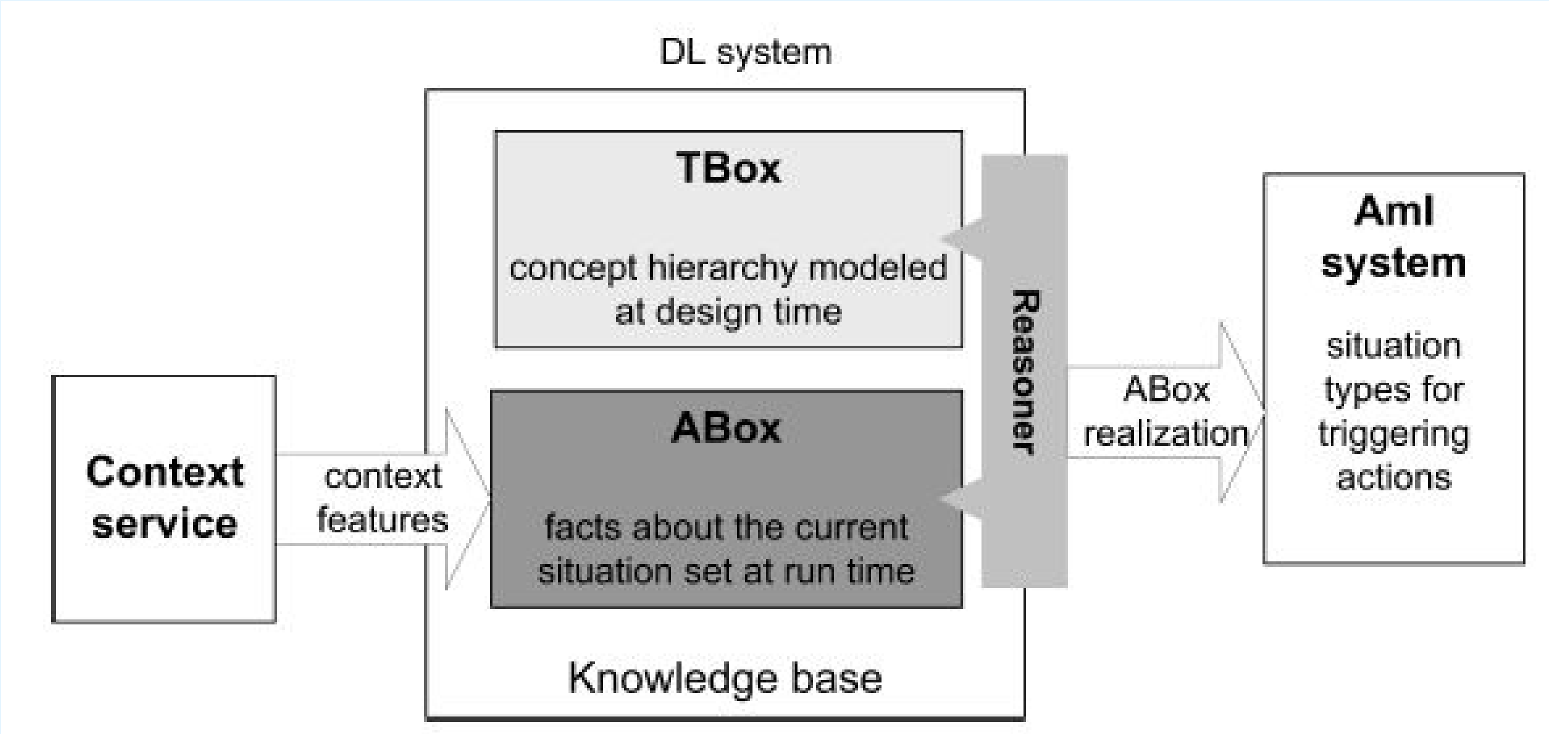
Kontextus-függő (context-aware) alkalmazások fejlesztése



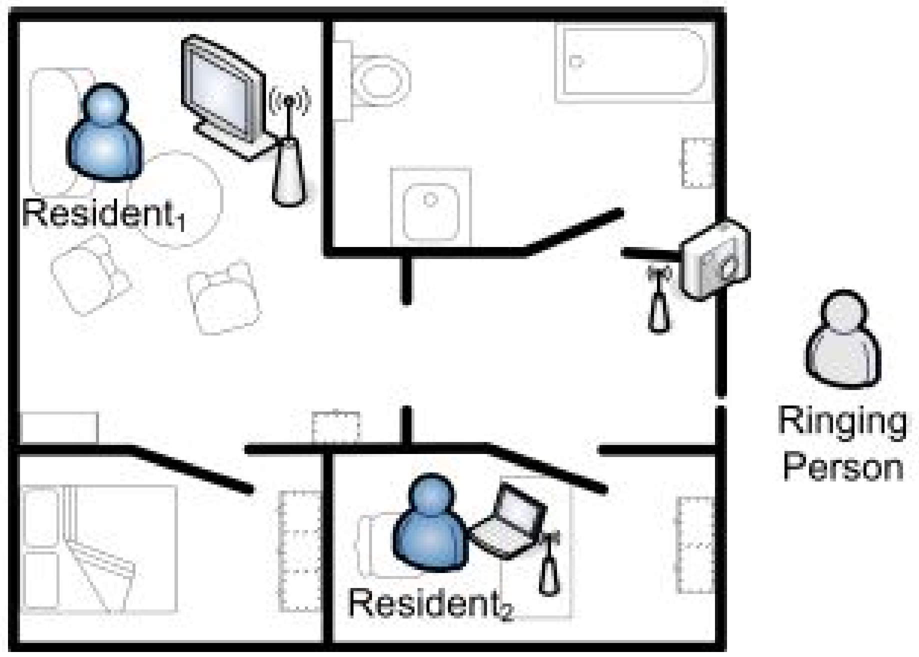
Conceptual architecture of situation-aware systems

User-defined context reasoning rules

Situation	Reasoning Rules
Sleeping	(?u locatedIn Bedroom) ∧ (Bedroom lightLevel LOW) ∧ (Bedroom drapeStatus CLOSED) ⇒ (?u situation SLEEPING)
Showering	(?u locatedIn Bathroom) ∧ (WaterHeater locatedIn Bathroom) ∧ (Bathroom doorStatus CLOSED) ∧ (WaterHeater status ON) ⇒ (?u situation SHOWERING)
Cooking	(?u locatedIn Kitchen) ∧ (ElectricOven locatedIn Kitchen) ∧ (ElectricOven status ON) ⇒ (?u situation COOKING)
Watching-TV	(?u locatedIn LivingRoom) ∧ (TVSet locatedIn LivingRoom) ∧ (TVSet status ON) ⇒ (?u situation WATCHINGTV)
Having-Dinner	(?u locatedIn DiningRoom) ∧ (?v locatedIn DiningRoom) ∧ (?u owl:differentFrom ?v) ⇒ (?u situation HAVINGDINNER)



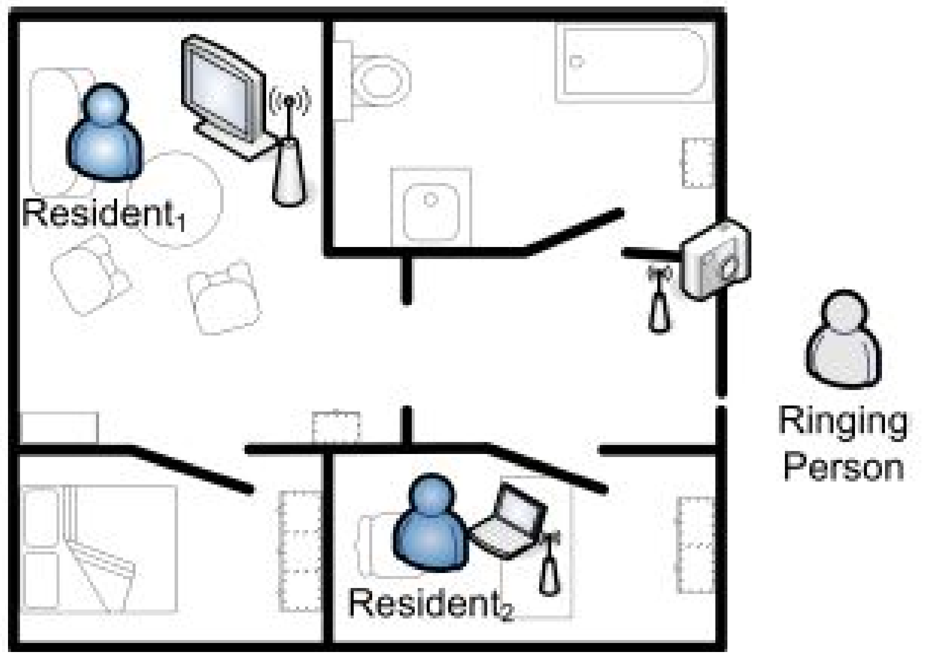
Using DL systems for recognizing situation types.



Intelligent door-lock scenario.

An automatic door lock should pick the next action to be taken depending on the person ringing at the door.
Door system is equipped with a video camera and a microphone and provides information about the ringing person.

Based on this information the door lock has to determine one of the following actions:
1. Open the door, if the person is authorized.
2. Ask a resident in case the person is unknown.
3. Do not respond at all or let the ringing person leave a message if no resident is available (similar to: nobody at home).



Intelligent door-lock scenario.

Example: For the holiday season a neighbour is asked to water the flowers while the residents are on vacation. The door lock system identifies the person ringing as the neighbour. Furthermore, the door system checks whether the ringing neighbour is authorized by a resident to enter the house. If in addition all residents are on vacation, the neighbour can be recognized as an authorized person and the door opens.

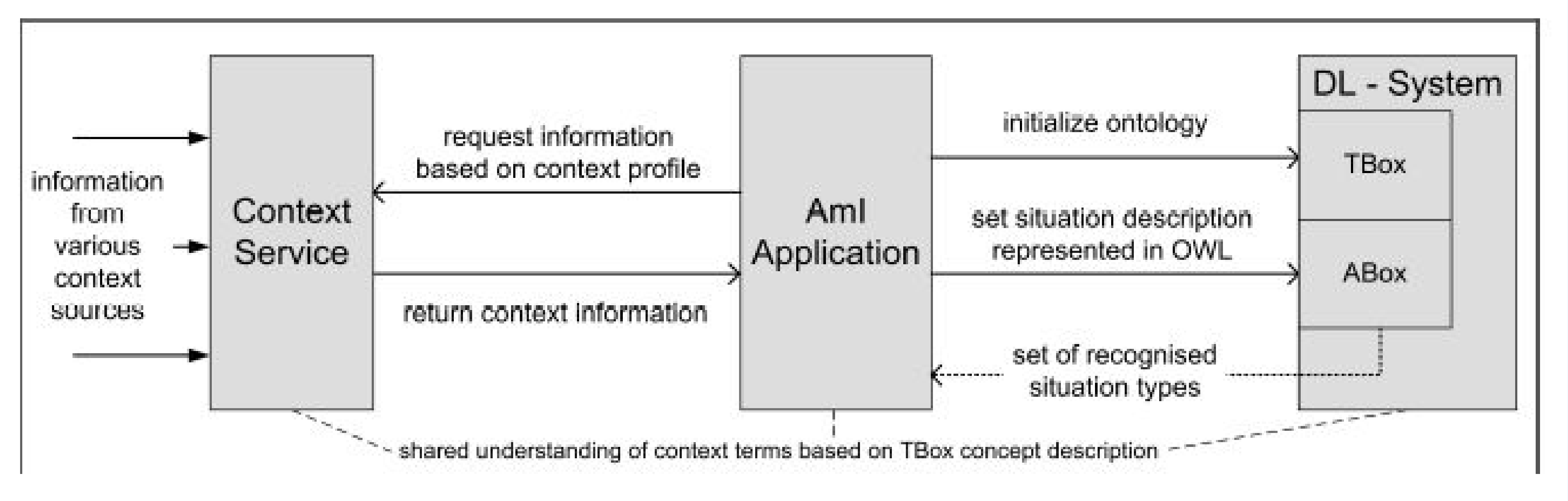
Scenario decomposition

Aspects of interest

Spatial decomposition

Temporal decomposition

Acting persons

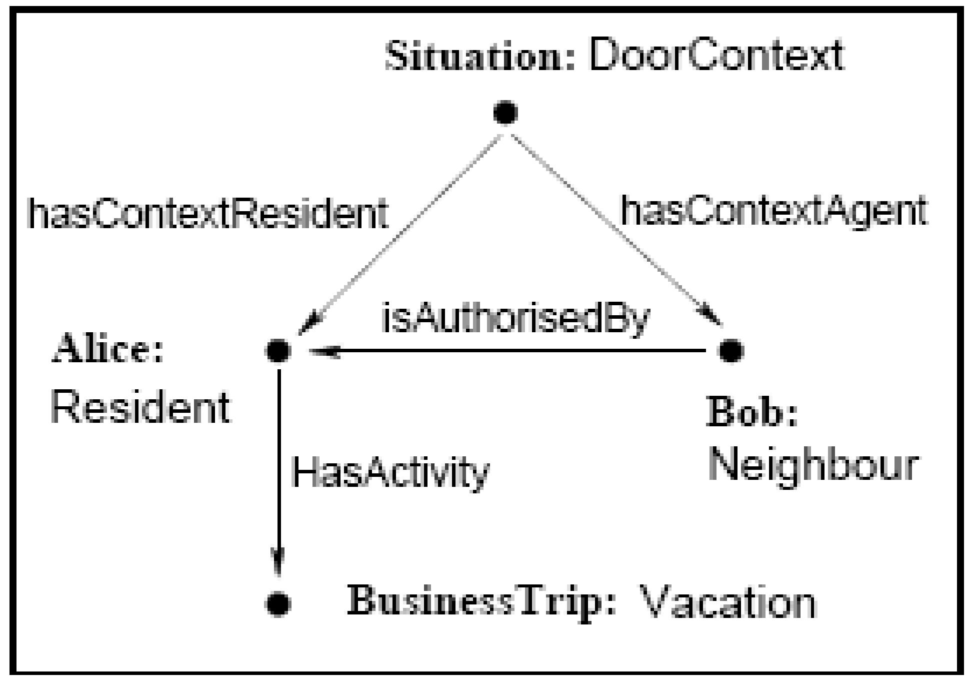


Architecture of the framework for situation-awareness

Intelligent door-lock scenario

Relevant context

identity and social relations
location (especially of interest is the location of the residents)
time
information about the presence
information about the devices a person owns and which
of them are currently active and in use



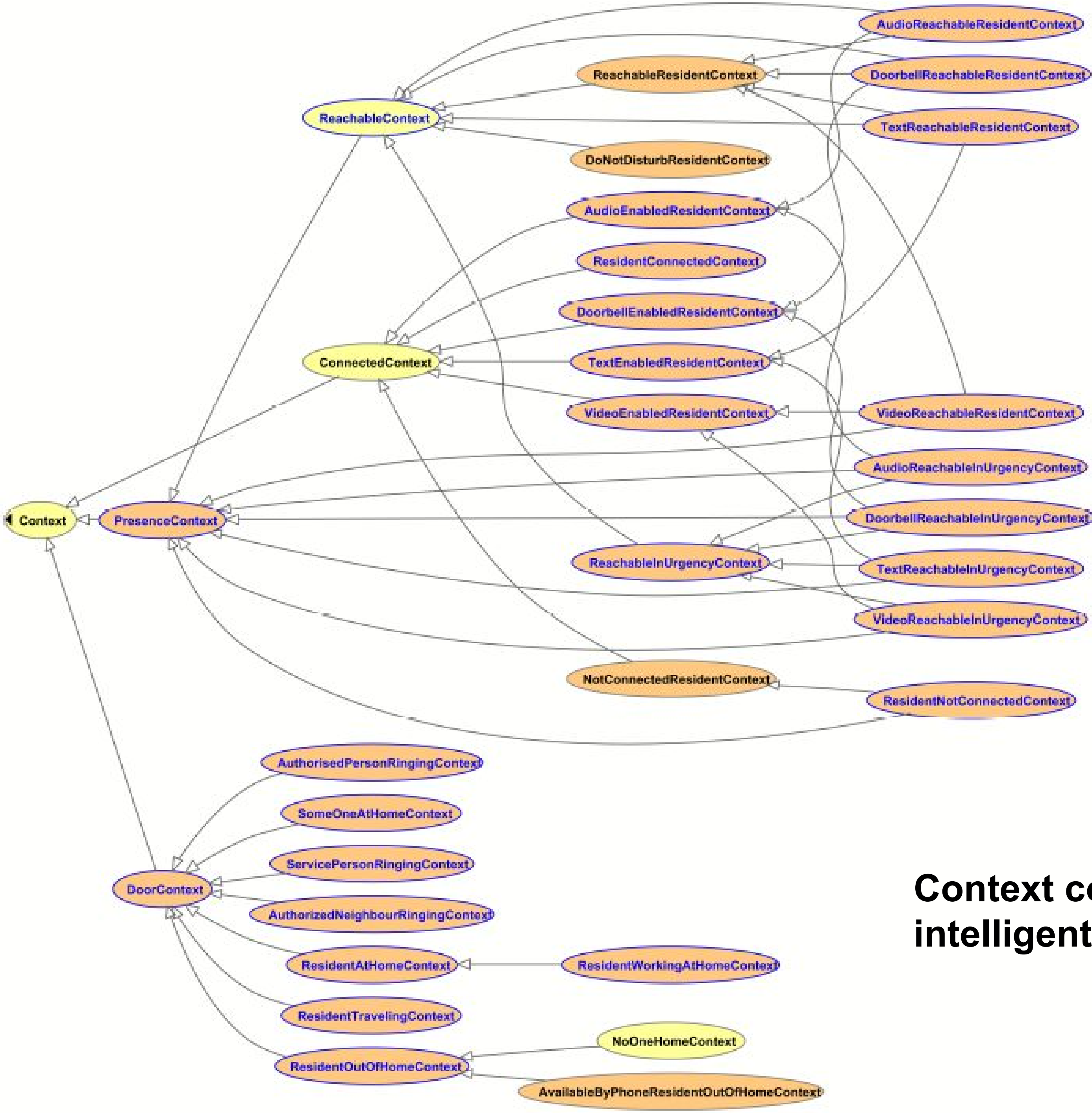
$$\mathtt{Resident} \equiv \mathtt{Person} \sqcap \exists\mathtt{livesAt}.\mathsf{Home}.$$

$$\mathtt{Neighbour} \equiv \mathtt{Person} \sqcap \exists\mathtt{livesAt}.(\neg\, \mathtt{Home} \sqcap (\exists\mathtt{nearby}.\mathtt{Home}))$$

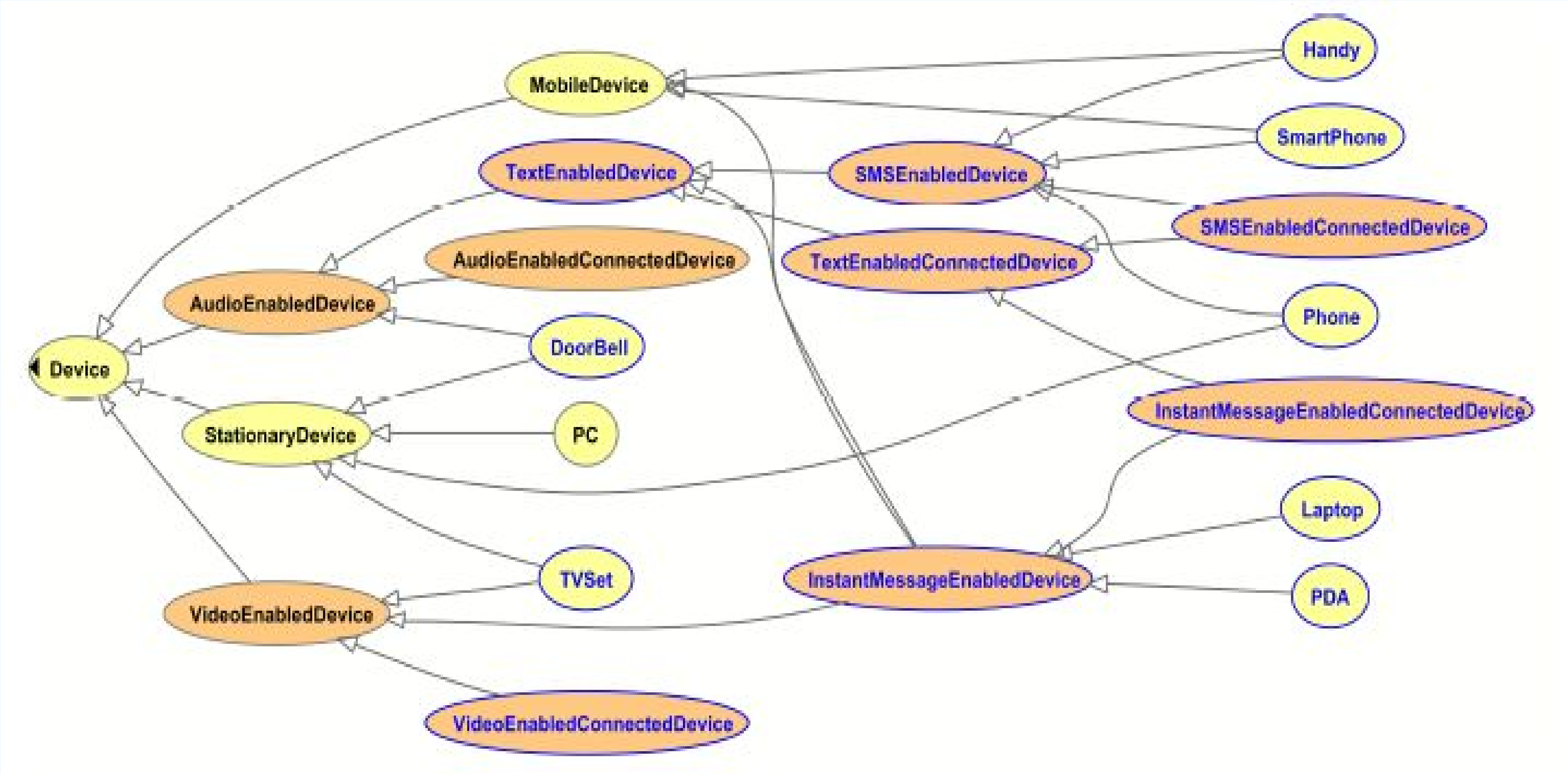
$$\begin{aligned}
\mathsf{VacationResident} &= \mathsf{Resident} \sqcap \exists\mathsf{hasActivity.Vacation} \\
\mathsf{AuthorisedPerson} &= \mathsf{Resident} \sqcup \exists\mathsf{AuthorisedBy.Resident} \\
\mathsf{AuthorisedNeighbour} &= \mathsf{Neighbour} \sqcap \\
&\quad (\exists\mathsf{AuthorisedBy.VacationResident})
\end{aligned}$$

$$\begin{aligned}
&\mathtt{SleepingResident} \equiv \\
&\quad \mathtt{Resident\ atHome} \sqcap \exists\mathtt{locatedAt}.(\mathtt{BedRoom} \sqcap \\
&\quad (\exists\mathtt{hasLightLevel}.(\mathtt{Dimmed} \sqcup \mathtt{Off})))
\end{aligned}$$

$$\begin{aligned}
&\mathsf{DoorContext} = \\
&\quad \mathsf{Context} \sqcap \exists\mathsf{hasContextAgent}.(\mathsf{Person} \sqcap \exists\mathsf{isRinging.Home}) \\
&\quad \sqcap \exists\mathsf{hasContextResident.Resident} \\
&\mathsf{AuthorisedPersonRingingContext} = \\
&\quad \mathsf{DoorContext} \sqcap \exists\mathsf{hasContextAgent.AuthorisedPerson} \\
&\mathsf{AuthorisedNeighbourRingingContext} = \\
&\quad \mathsf{DoorContext} \sqcap \exists\mathsf{hasContextAgent.AuthorisedNeighbour} \\
&\mathsf{ResidentOutOfHomeContext} = \\
&\quad \mathsf{DoorContext} \sqcap \exists\mathsf{hasContextResident.ResidentOutOfHome}
\end{aligned}$$



Context concepts for the intelligent door scenario



Concept hierarchy of device concept in the doors ontology