

Final Committee Draft ISO/IEC FCD	
Date: 2005-07-15	Reference number: ISO/JTC 1/SC 32N1337
Supersedes document SC 32Nxxx	

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ISO/IEC JTC 1/SC 32 Data Management and Interchange Secretariat: USA (ANSI)	Circulated to P- and O-members, and to technical committees and organizations in liaison for voting (P-members only) by: 2005-11-16 Please return all votes and comments in electronic form directly to the SC 32 Secretariat by the due date indicated.
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ISO/IEC FCD 15944-4:200x(E)

Title: Information technology — Business Agreement Semantic Descriptive Techniques
Part 4: Business Transactional Scenarios -- Accounting and Economic Ontology

Project: 1.32.31.01.04.00

4

Introductory note: The attached document is hereby submitted for a four-month letter
ballot to the National Bodies of ISO/IEC JTC 1/SC 32. The ballot
starts 2005-07-15.

Medium: E

No. of pages: 77

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Project Editor's Notes

Coordination of this work with evolving ontology work and evolving standards in ebXML and UN/CEFACT

The contents of this work are being governed and aligned with work in both the academic and the standards community.

- The primary academic standards for this document are the series of REA Model papers contained on the following website:

<http://www.msu.edu/user/mccarth4/rea-ontology>

These papers are individually referenced in an informative annex that describes the REA model.

- The primary standards documents are:
 - **ebXML Business Process Overview**
 - **ebXML Business Process Worksheets**
 - **ebXML Catalog of Common Business Processes**
 - **UN CEFACT Common Business Process Catalog Specification**
 - **UN CEFACT UMM User Guide**

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2. Work Plan

Stage	Date
WD	2002-09
CD	2004-01-29
FCD	2005-07-13
FDIS	
IS	

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3. Standard ISO/IEC Presentation Format

Time/resource constraints did not permit the addition of standard ISO/IEC presentation of this draft. This work will be completed as part of further document preparation.

Warning

This document is not an ISO International Standard. It is distributed for review and comment. It is subject to change without notice and may not be referred to as an International Standard.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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98 **Foreword**

99

100 ISO (the International Organization for Standardization) and IEC (the
101 International Electrotechnical Commission) form the specialized system for
102 worldwide standardization. National bodies that are members of ISO or IEC
103 participate in the development of International Standards through technical
104 committees established by the respective organization to deal with particular
105 fields of technical activity. ISO and IEC technical committees collaborate in fields
106 of mutual interest. Other international organizations, governmental and non-
107 governmental, in liaison with ISO and IEC, also take part in the work.

108 International Standards are drafted in accordance with the rules given in the
109 ISO/IEC Directives, Part 2.

110 In the field of information technology, ISO and IEC have established a joint
111 technical committee, ISO/IEC JTC 1. Draft International Standards adopted by
112 the joint technical committee are circulated to national bodies for voting.
113 Publication as an International Standard requires approval by at least 75 % of the
114 national bodies casting a vote.

115 International Standard ISO/IEC 15944-4 was prepared by Joint Technical
116 Committee ISO/IEC JTC JTC1, *Information Technology*, Subcommittee SC 32,
117 *Data Management and Interchange*.

118 ISO/IEC 15944 consists of the following parts, under the general title *Information*
119 *Technology — Business agreement semantic descriptive techniques*:

120 *Part 1: Operational aspects of Open-edi for implementation*

121 *Part 2: Registration of scenarios and their components as business objects*

122 *Part 3 : Open-edi description techniques*

123 *Part 4 : Open-edi business transaction ontology*

124 *Part 5: Identification and mapping of various categories of jurisdictional domains*
125 *as external constraints*

126 **0. Introduction**

127

128 **0.1 Purpose and Overview**

129

130 This work is motivated with important ideas from the ISO Open-edi specifications as
131 represented in ISO/IEC 15944-1: *Information technology -- Business agreement*
132 *semantic descriptive techniques - Part 1: Operational aspects of Open-edi for*
133 *implementation*. In that document and in some of its earlier foundational
134 expositions – such as ISO/IEC 14662: *Information technology – Open-edi reference*
135 *model* -- there were important concepts defined and interrelated such as business
136 transaction, fundamental activities of a business transaction, commitment, Person,
137 role, scenario, and others. A need for relating all of these concepts in a formal
138 framework for the Open-edi work is apparent.

139

140 This is a question of **ontology** -- a formal specification of the concepts that exist in
141 some domain of interest and the relationships that hold among them.¹ In this case,
142 the domains of interest are those that encompass Open-edi activities; that is: law,
143 economics and accounting in an extended sense – not the internal accounting of
144 one particular firm, but the accountabilities of each of the participants in an external
145 business transaction.

146

147 Ontologies are generally classified as either *upper-level ontologies* -- dealing with
148 generalized phenomena like time, space, and causality -- or domain ontologies –
149 dealing with phenomena in a specific field like military operations, manufacturing,
150 medical practice, or business. The economic and accounting ontology being used
151 in ebXML, in the UN/CEFACT modelling methodology, and ECIMF work is entitled
152 the **Resource-Event-Agent Ontology**, or **REA**². REA is used here as an
153 ontological framework for specifying the concepts and relationships involved in
154 business transactions and scenarios in the Open-edi sense of those terms. The
155 resulting framework is titled the Open-edi business transaction ontology (OeBTO).

156

157 The REA ontology is actually an elementary set of concepts derived from basic
158 definitions in accounting and economics. These concepts are illustrated most
159 simply with a UML class diagram in Figure 1 which illustrates the simple Resource-
160 Event-Agent structure that gives REA its name. A business transaction or
161 exchange has two REA constellations joined together, noting that the two parties to
162 a simple market transfer expect to receive something of value in return when they
163 trade. For example, a seller, who delivers a product to a buyer, expects a requiring
164 cash payment in return.

165

166 There are some specific points of synergy between the REA ontology and the ISO
167 Open-edi specifications as represented in ISO/IEC 15944-1 *Information technology*
168 *-- Business agreement semantic descriptive techniques - Part 1: Operational*

1 Thomas Gruber (1993) "A Translation Approach to Portable Ontologies," Knowledge Acquisition, pp. 199-220

2 Elements of the REA ontology as they are used in other standards work are explained in Informative Annex 8 in this document.

169 *aspects of Open-edi for Implementation.*

170

171 *Term 3.9: Commitment – The making or accepting of a right, obligation,*
172 *liability, or responsibility by a person.*

173 Commitment is a central concept in REA. Commitments are promises to
174 execute future economic events -- for example to fulfil an order by executing
175 a delivery event.

176

177 *Rule 1: Business transactions require both information exchange and*
178 *commitment exchange.*

179 REA firmly agrees with and helps give definition to this assertion. Reciprocal
180 commitments are exchanged in REA via economic contracts that govern
181 exchanges, while information exchange is tracked via business events that
182 govern the state transitions of business transaction entities that represent
183 various economic phenomena.

184

185 *Rule 39: Conceptually a business transaction can be considered to be*
186 *constructed from a set of fundamental activities. They are planning,*
187 *identification, negotiation, actualization and post-actualization. For REA,*
188 *actualization is the execution of economic events that fulfil commitments.*
189 *Planning and identification involve business partners with types of economic*
190 *resources, events, and persons, while negotiation is finalized by an*
191 *economic contract which is a bundle of commitments. The UN/CEFACT*
192 *Business Process Group has also defined negotiation protocols that assist in*
193 *forming commitments. The Open-edi set of activities and the REA economic*
194 *concepts will help each other tie together all the activities into a cohesive*
195 *business transaction, and then unite that transaction definition with its related*
196 *information models.*

197

198

199 Finally with regard to the preliminary agreement between Open-edi and REA, the
200 two major sets of ideas that characterize the Open-edi work – the specification of
201 Business Transactions and the configuration of Scenarios – correspond well at the
202 aggregate level to what the REA ontology calls the accountability infrastructure and
203 the policy infrastructure. A business transaction specifies in a descriptive sense
204 actual business events: what has occurred or has been committed to. Conversely,
205 a scenario is more prescriptive. It configures what could be or should be. The
206 realm of both descriptions and prescriptions is important to Open-edi and to REA,
207 and they can work well in developing standards for each.

208

209 **0.2 Ontology Definition**

210

211 According to the most widely accepted definition from Tom Gruber “An ontology is a
212 formal, explicit specification of a shared conceptualisation.”³ The individual

3 Thomas Gruber (1993) “A Translation Approach to Portable Ontologies,” Knowledge Acquisition, pp. 199-220

213 components of this meaning are each worth examining.

214

215 ○ *formal* = machine-readable

216 ○ *explicit specification* = concepts, properties, relations, constraints, and
217 axioms are explicitly defined

218 ○ *of a shared* = consensual knowledge

219 ○ *conceptualization* = abstract model of some phenomenon in the real
220 world

221

222 At present, the REA model is certainly an explicit specification of a shared
223 conceptualization of economic phenomena in the accounting community. A formal,
224 machine-readable specification is not proposed in this document; however, such
225 extensions may follow in other standards work.

226

227 **0.3 Use of the “Independent” and “Trading Partner” Perspective in the** 228 **Open-edi Ontology Work**

229

230 In normal business use, the naming perspective for the ontological primitives would
231 be that of the entrepreneur of one of the two trading partners engaged in
232 collaborative commerce. The other trading partner would ordinarily have a mirror-
233 image view. Thus a sale, a cash receipt, or a resource inflow for a particular
234 entrepreneur would become a purchase, a cash disbursement, or a resource
235 outflow for a corresponding trading partner. From this perspective, business events
236 and their accompanying economic phenomena would be modelled twice, once in
237 the database of each trading partner. However, for Open-edi purposes, or for that
238 matter for any other independent modelling of business collaborations like the BRV
239 level of the UN/CEFACT modelling methodology, this redundancy is not acceptable,
240 because it allows the states of the two representations to become inconsistent. This
241 difference in naming perspective is explained below and illustrated in Figure 2.⁴

242

243 Figure 2 illustrates three independent value chains for three different enterprises.
244 Each company has a connected network of business processes that takes its initial
245 input of resources (called factor inputs for their production functions) and transforms
246 them via cumulative flows of goods, services, and cash into an output for that firm’s
247 downstream customers. For Open-edi collaboration modelling, these internal
248 processes are not relevant until a resource flow crosses enterprise boundaries as is
249 illustrated for Enterprise #2 which accepts materials from Enterprise #1 and which
250 delivers materials to Enterprise #3 (most probably in both cases for cash payments
251 in return). The two dotted lines with double-headed arrows show these inter-
252 enterprise events.

253 The independent or collaboration perspective of resource flows is anchored on the
254 view of the eye outside of Enterprise #2. This view sees both exchanges as
255 conceptually similar with flows of materials being requited by flows of funds. Such a

4 Figures 2 and 3 were contributed by the Japanese delegation to SC 32, led by Katsuhiro Morita.

256 perspective is quite different than that of the eye inside of Enterprise #2 which sees
257 the flow between Enterprise #1 to Enterprise #2 as a “purchase” and the flow
258 between Enterprise #2 and Enterprise #3 as a “sale.” Note that an eye inside of
259 Enterprise #1 (not shown on diagram) would have modelled the “purchase” of
260 Enterprise #2 as a “sale” of Enterprise #1, hence the redundancy and the inevitable
261 inconsistency.

262

263 Business process modeling can take either of the perspectives shown by the eyes
264 of Figure 2, but the independent perspective is clearly the choice for Open-edi. This
265 leads to the concept of a business collaboration that is illustrated in Figure 3. Most
266 generally, there is a value exchange between two Persons, with one assuming the
267 role of a “buyer” (has money, wishes goods or services) and the other assuming the
268 role of a seller (has goods or services, wishes money). It is also possible to anchor
269 the independent view on time, with one event being the initiating flow and the
270 requiting event being the responding flow. In either case, there is a possibility of
271 having a third party in on the collaboration such as a shipment provider or an
272 escrow agent. For internal database purposes of corporate accountability, “trading
273 partner perspective” terms are directly derivable from “independent perspective”
274 terms.

275

276 **0.3 The “Open-edi Business Transaction Ontology” (OeBTO)**

277

278 The prior two sections have suggested :

279

- 280 • That the components of the REA domain ontology model are sufficiently well-
281 defined, stable, and well-known that they can clearly serve as the basis for
282 an ontological specification of the concepts involved in collaborative
283 exchanges between trading partners; and
- 284 • That the components of that model must be viewed from the outside
285 perspective of a modeller viewing the economic phenomena independently.

286

287 Because the primitive economic terms are being adopted here for use with the
288 operational aspects of Open-edi from ISO/IEC 15944-1, the ontology to be defined
289 will be termed the “Open-edi Business Transaction Ontology” (OeBTO). Its
290 definition is:

291

292 A formal specification and definition of the concepts pertaining to business
293 transactions and scenarios and the relationships that hold among these
294 concepts.

295

296 From the definitional foundations of both ISO/IEC 15944-1 and the REA model, it
297 follows that the OeBTO will follow these principles:

298

- 299 • As a business transaction ontology, a distinguishing characteristic of
300 OeBTO is that in addition to information exchange, it incorporates
301 commitment exchange among autonomous Persons.

- 302 • An OeBTO requires the use of clear and pre-defined rules, principles, and
- 303 guidelines (see Clause 5.1 of 15944-1).
- 304 • An OeBTO is neutral in terms of technology, representation, and
- 305 application.
- 306 • The scope of OeBTO covers all areas of business transactions (e.g.,
- 307 public/private, industry sectors, international, regional, etc.).
- 308 • The semantics of the concepts represented in the OeBTO are explicitly
- 309 specified and constrained.

310

311 Clause 1 and Clause 2 provide scope and normative references for OeBTO. The
312 basic OeBTO definitions are first enumerated in Clause 3, while Clause 4 provides
313 a table of symbols and abbreviations. Clause 5 provides the *declarative* substance
314 for this document – a set of UML class diagrams and conceptual explanations that
315 circumscribe the Open-edi Business Transaction Ontology. Clause 6 explains the
316 mechanics of a business transaction state machine – the procedural component of
317 an OeBTO – while Clause 7 explains the constraint component of OeBTO – its
318 repository for business rules. Clause 8 and Clause 9 provide an informative annex
319 on REA model background and a set of references.

320

321

322

323

324

325

326

327

328 **1. Scope**

329

330 This Business Operational View (BOV) related standard addresses collaborations
331 among independent trading partners as defined in ISO/IEC specification 15944-

332 1. It applies to both binary collaborations (buyer and seller) and mediated

333 collaborations (buyer, seller, third-party).

334

335

336 **2. Normative References**

337

338 The following referenced documents are indispensable for the application of this
339 document. For dated references, only the edition cited applies. For undated
340 references, the latest edition of the referenced document (including any
341 amendments) applies.

342

343 ISO/IEC 14662: 2004 Information Technology - Open-edi reference model

344 IEC/ISO 15944-1: 2002 Information technology- Business agreement semantic
345 descriptive techniques Part 1: Business operational aspects of Open-edi for
346 implementation

347 **3. Definitions**

348

349 **3.1**

350 **agent**

351 a *Person* acting for another *Person* in a clearly specified capacity in the
352 context of a *business transaction*

353 [ISO/IEC 15944-1:2002 (3.1)]

354

355 **3.2**

356 **agreement**

357 an arrangement of reciprocated *economic commitments* between two
358 partners where the abstract specification of terms of trade is incomplete and
359 not subject to legal enforcement

360

361 **3.3**

362 **attribute**

363 data representing properties of objects

364

365 NOTE: For example, a *Person* might have a name attribute, a date-of-birth
366 attribute, and a national-identifying-number attribute.

367

368 **3.4**

369 **bilateral transaction**

370 a subtype of a *business transaction* where the *Persons* include only the *buyer*
371 and the *seller*, or alternatively other *Persons* acting as *agents* for the *buyer* or
372 *seller*

373

374 **3.5**

375 **business event**

376 an occurrence in time that partners to a *business transaction* wish to monitor
377 or control

378

379 NOTE: *Business events* are the workflow tasks that business partners need
380 to accomplish to complete a *business transaction*. As *business events* occur,
381 they cause a *business transaction* to move through its various phases of
382 planning , identification, negotiation, actualization, and post-actualization.

383

384 **3.6**

385 **business location**

386 the geographic site where an *economic event* is deemed to occur with its
387 attendant transfer of an *economic resource* from one *Person* to another.

388

389 **3.7**

390 **Business Operational View (BOV)**

391 A perspective of *business transactions* limited to those aspects regarding the
392 making of business decisions and *commitments* among organizations, which

393 are needed for the description of a *business transaction*
394 [ISO/ FDIS 14662:2003]

395

396 **3.8**

397 **business transaction**

398 a predefined set of activities and/or processes of *Persons* which is which is
399 initiated by an *organization* to accomplish an explicitly shared business goal
400 and terminated upon recognition of one of the agreed conclusions by all the
401 involved *organizations* although some of the recognition may be implicit
402 [ISO/ IEC 14662:1997 (3.1.4)]

403

404 NOTE: *Business transactions* may normally proceed through five process
405 phases: Planning, identification, negotiation, actualization, and post-
406 actualization.

407

408 **3.9**

409 **business transaction entity**

410 the computable representation of any real world entity that participates,
411 occurs, or is materialized during a *business transaction*

412

413 **3.10**

414 **business transaction entity type**

415 the abstract specification of a *business transaction entity*, detailing its
416 recommended characteristics, its recommended methods, and its
417 recommended life-cycle states

418

419 NOTE: A business transaction entity type will usually specify the types of
420 business events that cause a business transaction entity of this type to
421 proceed through its different states as the business transaction itself
422 progresses through its phases of planning, identification, negotiation,
423 actualization, and post-actualization.

424

425 **3.11**

426 **buyer**

427 a *Person* who aims to get possession of a good, service, and/or right through
428 providing an acceptable equivalent value, usually in money, to the *Person*
429 providing such a good, service, and/or right
430 [ISO/IEC 15944-1:2002 (3.8)]

431

432 **3.12**

433 **collaboration space**

434 the business activity space where an *economic exchange* of valued resources
435 is viewed independently and not from the perspective of any business partner

436

437 NOTE: In collaboration space, an individual partner's view of economic
438 phenomena is de-emphasized. Thus, the use common business and

439 accounting terms like purchase, sale, cash receipt, cash disbursement, raw
440 materials, and finished goods is not allowed because they view resource
441 flows from a participant's perspective.
442

443 **3.13**

444 **commitment**

445 the making or accepting of a right, obligation, liability, or responsibility by a
446 *Person* that is capable of enforcement in the jurisdiction in which the
447 *commitment* is made
448 [ISO/IEC 15944-1:2002 (3.9)]
449

450 **3.14**

451 **constraint**

452 a rule, explicitly stated, that prescribes, limits, governs, or specifies any
453 aspect of a *business transaction*
454 [ISO/IEC 15944-1:2002 (3.11)]
455

456 **3.15**

457 **custody**

458 an association between a *Person* and an *economic resource* where the
459 *Person* has physical control over the resource or controls access
460

461 **3.16**

462 **data**

463 a reinterpretable representation of information in a formalized manner suitable
464 for communication, interpretation, or processing
465 [ISO/IEC 15944-1:2002 (3.13)]
466

467 **3.17**

468 **defined market model**

469 a trade model where the buyer and seller accept the entry terms of market in
470 advance and where that market has an accepted and recognized source for
471 business rules and conventions
472

473 NOTE: In a defined market, the phases of a business transaction –planning,
474 identification, negotiation, actualization, and post-actualization – are governed
475 by the rules and conventions of the particular defined market.
476

477 **3.18**

478 **duality**

479 an association between *economic events* where one is the legal or economic
480 consideration for the other in an exchange
481

482 **3.19**

483 **economic bundle**

484 an association between economic commitments and the economic contract

485 that legally bundles those promises and binds them to the two partners who
486 negotiated them

487

488 **3.20**

489 **economic claim**

490 the expectation of one *Person* to receive a future inflow of *economic*
491 *resources* from another *Person* because of an *economic exchange* which is
492 presently incomplete

493

494 **3.21**

495 **economic commitment**

496 a type of *commitment* by one *Person* to transfer *economic resources* to
497 another *Person* at some specified point in the future

498

499 **3.22**

500 **economic contract**

501 a bundling of reciprocated *economic commitments* between two partners
502 where the abstract specification of the *economic resource* transfers between
503 the two parties is deemed legally complete and enforceable

504

505 **3.23**

506 **economic control**

507 an association between a *Person* and an *economic resource* where the
508 *Person* either owns the resource or is otherwise able to derive economic
509 benefit (utility) from it

510

511 **3.24**

512 **economic event**

513 an occurrence in time wherein ownership of an *economic resource* is
514 transferred from one *Person* to another *Person*

515

516 **3.25**

517 **economic event type**

518 the abstract specification of an *economic event* where its grouped properties
519 can be designated without attachment to an actual, specific occurrence in
520 time

521

522 NOTE: Example of attributes at the type level for events might be expected-
523 duration or standard-pricing-percentage.

524

525 **3.26**

526 **economic exchange**

527 an *economic exchange* is a type of a business transaction where the goal is
528 an exchange of *economic resources* between two *Persons* where both
529 parties derive higher utility after the completed transaction

530

531 NOTE: An *economic exchange* usually involves two *economic events* with
532 different types of *economic resources* flowing in opposite directions. For
533 example, an exchange of cash for a good involves a shipment with a required
534 payment following.

535

3.27

536 **economic resource**

537 a good, right, or service of value, under the control of a Person

538

539

3.28

540 **economic resource type**

541 the abstract specification of an *economic resource* where its grouped
542 properties can be designated without attachment to an actual, specific
543 resource

544

545

546

547

548

NOTE: Example of attributes at the type level for a resource like an
automobile might include its designated fuel capacity or its maximum
expected range.

549

3.29

550 **economic role**

551

552

553

554

555

the abstract specification of a *Person* for economic purposes where its
grouped properties can be designated without attachment to an actual Person

556

557

NOTE: An example economic role might be qualified buyer or approved

558

559

3.30

560 **entity**

561

562

563

564

any concrete or abstract thing that exists, did exist, or might exist, including

associations among these things

[ISO/IEC 15944-1:2002 (3.20)]

565

3.31

566

567

568

569

external constraint
a constraint which takes precedence over *internal constraints* in a *business transaction*, i.e., is external to those agreed upon by the parties to a *business transaction*

[ISO/IEC 15944-1:2002 (3.23)]

570

571

3.32

572

573

573 **fulfillment**

574

575

576

an association between an *economic commitment* and an *economic event*
where the event executes the promised resource flow from one *Person* to
another

577

578 NOTE: For example, a delivery to a customer would fulfill that customer's
579 sale order.

580

581 **3.33**

582 **governed**

583 the association between an *agreement* and the *business transaction* whose
584 conduct and phases are subject to that *agreement*

585

586 **3.34**

587 **individual**

588 a *Person* who is a human being , i.e., a natural *Person*, who acts as a distinct
589 indivisible entity or is considered as such
590 [ISO/IEC 15944-1:2002 (3.28)]

591

592 **3.35**

593 **information**

594 knowledge concerning objects, such as facts, events, things, processes, or
595 ideas, including concepts that within a certain context have a particular
596 meaning

597 [ISO/IEC 15944-1:2002 (3.29)]

598

599 **3.36**

600 **information bundle**

601 the formal description of the semantics of the information to be exchanged by
602 *Open-edi Parties* playing *roles* in an *Open-edi scenario*

603 [ISO/IEC 15944-1:2002 (3.30)]

604

605 **3.37**

606 **internal constraint**

607 a constraint which forms part of the *commitment(s)* mutually agreed to among
608 the parties to a *business transaction*

609 [ISO/IEC 15944-1:2002 (3.33)]

610

611 **3.38**

612 **location type**

613 the abstract specification of an *economic location* where its grouped
614 properties can be designated without attachment to an actual place

615

616 NOTE: An example location type might be accepted shipping facility or
617 approved hospital location.

618

619 **3.39**

620 **materialized**

621 an association between an *economic event* and an *economic claim* where the
622 occurrence of the event causes the claim to come into existence

623
624 **3.40**
625 **mediated transaction**
626 a subtype of a *business transaction* where a third party mediates between
627 the *partners*
628
629 **3.41**
630 **object**
631 any part of the perceivable or conceivable world
632 [ISO/IEC 15944-1:2002 (3.36)]
633
634 **3.42**
635 **Open-edi**
636 electronic data interchange among multiple autonomous *organizations* to
637 accomplish an explicit shared business goal according to Open-edi standards
638 [ISO/IEC 14662:1997 (3.1.9)]
639
640 **3.43**
641 **Open-edi Party (OeP)**
642 an *organization* that participates in Open-edi
643 [ISO/IEC 14662:1997 (3.1.11)]
644
645 **3.44**
646 **Open-edi scenario**
647 a formal specification of a class of *business transactions* having the same
648 business goal
649 [ISO/IEC 14662:1997 (3.1.12)]
650
651 **3.45**
652 **organization**
653 a unique framework of authority within which a *Person* or *Persons* act, or are
654 designated to act, towards some purpose
655 [ISO/IEC 15944-1:2002 (3.44)]
656
657 **3.46**
658 **participates**
659 the association between an *economic event* and each of the two *Persons*
660 participating in the event
661
662 NOTE: Usually there is a “from” association and a “to” association,
663 depending upon the direction of the flow of the economic resource.
664
665 **3.47**
666 **partner**
667 a subtype of *Person* that includes *buyer* and *seller*
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3.48

Person

an entity, i.e., a natural or legal person, recognized by law as having legal rights and duties, able to make *commitment(s)*, assume and fulfill resulting obligations(s), and able of being held accountable for its action(s)
[ISO/IEC 15944-1:2002 (3.47)]

3.49

process

a series of actions or events taking place in a defined manner leading to the accomplishment of an expected result
[ISO/IEC 15944-1:2002 (3.53)]

3.50

reciprocal

an association between *economic commitments* where the promise by one *partner* to execute an *economic resource* transfer in the future is reciprocated by the other *partner* promising a requited transfer in the opposite direction

3.51

regulator

a *Person* who has the authority to prescribe *external constraints* which serve as principles, policies, or rules governing or prescribing the behavior of *Persons* involved in a *business transaction* as well as the provisioning of goods, services, and/or rights interchanged
[ISO/IEC 15944-1:2002 (3.59)]

3.52

resource-flow

the association between an *economic event* and an *economic resource*

NOTE: A common example would be a resource-flow between some inventory and the shipment that caused control of that inventory to flow from one *Person* to another.

3.53

responsibility

an association between *Persons* where one is responsible to the other or between a *Person* and an *organization* where that *Person* is assigned

NOTE: Subtypes of *Persons* include *individuals* and *organizations*, so an *individual* may be responsible to another *individual* or an *individual* may be responsible to an *organization*.

3.54

715 **seller**
716 a *Person* who aims to hand over voluntarily or in response to a demand or a
717 request, a good, service, and/or right to another *Person* and in return receives
718 an acceptable equivalent value, usually in money, for the good, service, or
719 right provided
720 [ISO/IEC 15944-1:2002 (3.62)]
721
722 **3.55**
723 **Semantic Component (SC)**
724 a unit of *information* unambiguously defined in the context of the business
725 goal of the *business transaction*
726 [ISO/IEC 14662:1997 (4.1.2.2)]
727
728 **3.56**
729 **settlement**
730 an association between a requiring *economic event* and an *economic claim*
731 where the occurrence of the event causes the claim to expire
732
733 **3.57**
734 **site**
735 the association between an *economic event* and the *location* where the
736 transfer of *economic resources* involved in that event is deemed to have
737 occurred
738
739 **3.58**
740 **specification**
741 the association between an *economic commitment* and the abstract
742 properties of an *economic event*, an *economic resource*, a *partner*, or a
743 *location*
744
745 **3.59**
746 **third party**
747 a *Person* besides the two primarily concerned in a *business transaction* who
748 is agent of neither and who fulfills a specified role or function as mutually
749 agreed to by the two primary *Persons* or as a result of *external constraints*
750 [ISO/IEC 15944-1:2002 (3.65)]
751
752 **3.60**
753 **typification**
754 the association between a concrete *entity* and the abstract specification of its
755 grouped properties
756
757 **3.61**
758 **undefined market model**
759 a trade model where participants are not registered in advance and where all
760 phases of a business transaction (planning, identification, negotiation,

761 actualization, and post-actualization) must be performed

762

763 **3.62**

764 **vendor**

765 a *seller* on whom consumer protection requirements are applied as a set of
766 *external constraints* on a *business transaction*

767 [ISO/IEC 15944-1:2002 (3.67)]

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4. Symbols and Abbreviations

Acronym	Description
BOV	Business Operational View
BTE	Business Transaction Entity
BTET	Business Transaction Entity Type
ebXML	electronic business eXtended Markup Language
ECIMF	E-Commerce Integration Meta-Framework
EDI	Electronic Data Interchange
ISO	International Standards Organization
OCL	Object Constraint Language
OeBTO	Open-edi Business Transaction Ontology
OeP	Open-edi Party
REA	Resource-Event-Agent
SC	Semantic Component
UML	Unified Modelling Language
UN	United Nations
UN/CEFACT	United Nations Centre for Trade Facilitation and Electronic Business

797

798 **5. The Declarative Component of an OeBTO – Primitive and Derived Data**
799 **Classes**

800

801 **5.1 Persons and Economic Resources**

802

803 One of the most fundamental ideas in Open-edi is the category of *Person* as an
804 entity recognized as having legal rights and duties, able to make commitments, and
805 fulfill resulting obligations. *Person* can be decomposed into three separate
806 subclasses based on identity as indicated into 15944-1: individual, organization, and
807 public administration. These subclasses are illustrated in Figure 4.

808

809 A second very important notion in the OeBTO is the concept of an *Economic*
810 *Resource* which is something of value under the control of a *Person*. These two
811 fundamental categories appear on the left of Figure 5, connected by an *economic*
812 *control* relationship which indicates that the *Person* either owns the resource or is
813 otherwise able to derive economic value (utility) from it.

814

815 Onto the right side of Figure 5 is now added an additional *Person* and economic
816 resource association, thus setting the stage for a possible exchange where both
817 parties might view control of the other *Person*'s resource as a means of deriving
818 higher utility than present circumstances render. This "value exchange" as it is
819 titled in the collaboration space of Figure 3 is the basis for what Open-edi calls a
820 *business transaction* between the two persons. When those business transaction
821 occur, *Persons* are able to play roles as indicated the different subtyping shown in
822 Figure 6.

823

- 824 • *Partner* which itself further specializes to *Buyer* (has money, desires
825 goods) and *Seller* (has goods, desires money).
- 826 • *Regulator* which represents *Persons* who impose external constraints on
827 Business Transactions.
- 828 • *Third Party* which specializes to a number of other classes such as
829 Escrow, Mediator, Guarantor, and Notary.

830

831 **Agents** are a special subtype in Open-edi who can act for any *Person*.

832

833 Figure 7 illustrates some of the possible subtyping for the economic resource
834 primitive into these classes.

835

- 836 • *Goods* which are tangible resources to include:
 - 837
 - 838 ○ *Materials* including capital assets (like trucks), basic raw materials
839 and natural resources (like steel or petroleum) plus sub-
840 components of a larger assembled product (like seats for an
841 automobile).
 - 842 ○ *Real Estate*, like office buildings or warehouses.
 - 843 ○ *Funds* like money or marketable securities.

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- *Services* which are the provision of value-adding activities by a provider to a consumer to include:
 - *Human Services* like temporary workers or consultants.
 - *Transportation Services* like packing/picking or actual shipments.
 - *Regulatory Services* such as the right to import/export or the right to do business in a certain segment or area.
 - *Warranty Services* such as the automatic provision of replacement goods under faulty judgments.
 - *Insurance Services* such as guaranteed payment under exigent circumstances.

- *Rights* which are intangible resources to include examples like *Intellectual Products (IPR)* and *Rights-of-way*.

Figure 7 also shows a recursive association that is especially important in ontological terms because it reflects an important aspect of economic reality -- that economic resources often have component structures. This means that their value is often derived from an assembly of other resources. For a product example, those components could be the physical material, its advertised cache, its delivered-to-the-door-status, and its warranty.

In Open-edi, a business transaction usually involves an economic exchange of resources between Persons with competing economic interests, each attempting to maximize his or her own economic utility. As portrayed in 15944-1 and shown in Figure 8, there are two additional fundamental elements of a Business Transaction Model besides PERSON (discussed amply above). The first of these is the DATA involved in the transaction, and the ontological categories for capturing that data will be the topic for the rest of this Clause 5. The other fundamental element is the PROCESS involved in a business transaction and that will be the main topic for the following Clause 6. Clause 7 illustrates the constraint component where the business rules concerning both data and processes are enumerated.

5.2 The Normative Data Categories for a Business Transaction Involving an Economic Exchange: Resources, Events, and Persons Plus Their Fundamental Relationships

The UML class diagram of Figure 9 illustrates the high level semantic view of the essentials of an economic exchange. In Open-edi, the full details of this exchange are effected within the scope of a single business transaction as trading partners identify each other, negotiate commitments, and engage in the actual exchange of resources with value.

890 As a starting point for ontological definition, this collaboration space diagram
891 concentrates on the object answers to four fundamental questions:

892

- 893 • **Who** is involved in the collaboration (Persons)?
- 894 • **What** is being exchanged in the collaboration (Economic Resources)?
- 895 • **When** (and under what trading conditions) do the components of the
896 exchange occur (Economic Events)?
- 897 • **Why** are the trading partners engaged in the collaboration (duality
898 relationships between resource flows)?

899

900 The normative infrastructure of the Open-edi Business Transaction Ontology
901 (OeBTO) encompasses these essential question components, as explained in
902 section 5.2 that follows. Section 5.3 illustrates the ontological components that
903 result from typifying the OeBTO normative infrastructure, while section 5.4 deals
904 with the non-normative extensions of claims and locations. Section 5.5 discusses
905 the elaborate commitment structures of the OeBTO, and section 5.6 finishes this
906 chapter by accounting for the extended ontology objects of scenarios and markets.

907

908 Figure 9 illustrates the basic economic primitives of OeBTO. An actual value
909 exchange in the collaboration space of Open-edi between a buyer and a seller
910 would involve two instances of this object pattern. A full example of this is shown in
911 Figure 10 with a delivery of product followed by a payment of cash. In very general
912 terms, a full economic exchange of value in collaboration space is defined as a
913 *Business Transaction* in the Open-edi ontology. It is important to remember that
914 *Bilateral Transactions* between a buyer and a seller constitute the basic
915 collaborative unit in Open-edi. These bilateral transactions may be aggregated to
916 *Mediated Transactions* involving more than two *Persons*. However, these mediated
917 transactions may always be decomposed into binary components.

918

919 **5.2.1 Entity Definitions:**

920

- 921 • A *Person* is a natural or legal person or organizational unit empowered to
922 control the flow of economic resources (including his or her own labor) by
923 engaging in economic events. Persons are also empowered to make
924 commitments or promises to execute resource flows in the future. The
925 *Person* class may also include persons and agencies that are responsible
926 for subordinates' participation in economic events. A subset of *Person*
927 is *Partner*; partners are Persons who play the leading roles in business
928 transactions as sellers and buyers (or alternatively, as producers and
929 consumers of services).
- 930 • An *Economic Resource* is a scarce good, right, or service that possesses
931 utility (economic value) and that is presently under the identifiable control
932 of a particular Person.
- 933 • An *Economic Event* most simply is an inflow or outflow of an economic
934 resource. Economic events reflect changes in economic resources
935 resulting from exchanges, conversions, or transportation.

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Relationship Definitions:

- A *resource-flow* relationship is an association between an economic resource and an economic event. From the independent perspective, *resource-flow* instances are matched in bi-directional fashion with each party both giving and taking in the same exchange.
- An *accountability* relationship is an association between a Person and an economic event. Economic events normally have two accountability relationships with independent parties who have competing economic interests (that is, they are said to have an “arm’s length relationship with each other). One of these is specialized on the class diagram of Figure 6 as *from* and the other as *to*, indicating again the independent perspective of collaboration.
- A *duality* relationship is an association between two (or more) economic events where one is the economic or legal consideration for the other in an economic exchange. Dualities are needed for every binary component of mediated transactions.
- A *custody* relationship is an association between a Person and an economic resource where physical control or access to physical control possession is indicated.
- *Responsibility* is a relationship between (among) two or more Persons. These *responsibility* associations indicate hierarchical orderings within an enterprise that are necessarily revealed to trading partners in a collaboration model.

Addition of *Business Event* to Basic Pattern:

In Figure 11, the primitive *Business Event* has been added to the basic OeBT ontology pattern. A *business event* is an occurrence in time in collaboration space that Persons wish to plan, control, monitor, or evaluate. To bring about the occurrence of an economic event, it is often necessary to perform multiple business events. Additionally, business events may also be aggregates of other, finer-grained business events, so the UML component structure shown is possible. In a state machine sense where many elements of the OeBT ontology become *business transaction entities* (representing *business transaction entity types* as explained in Clause 6)) with defined object states and defined object lifecycles, a business event can be defined more precisely as an occurrence that causes a state change in one or more business transaction entities.

5.3 Extension Of The Ontology Into Types

Abstract concepts are information structures used to describe the intangible

982 components of actual phenomena. For ontologists, this is an important distinction.
983 In the OeBT ontology, “type images” are used to represent the abstract structure of
984 economic phenomena. For the construction of abstract concepts, the common
985 abstraction mechanism of typification is used.

986

987 Typification captures descriptions that apply to a group of actual phenomena. For
988 instance with two 15944-1 examples, the definition of “goods” as an economic
989 resource might involve some notion of “consumption” while “rights” as an economic
990 resource might not. Also important is that the definition of a “right” is preserved
991 even when no actual rights exist in the universe of discourse. In Figure 12, the
992 grouping and abstraction involved with these two examples is illustrated. The group
993 “goods” would have “consumability” as part of its definition, and it could also have
994 differential group operations as part of its definition (for example, the valuation of
995 goods might involve depreciation while that of rights might involve amortization).

996

997 When type images are connected with each other as illustrated in the dotted
998 associations of Figure 13, policy and planning artifacts often emerge, so this
999 abstraction mechanism is especially important to the pre-actualization components
1000 (planning, identification, and negotiation) of an Open-edi Business Transaction. For
1001 example, parties often specify in advance the types of goods they desire to be
1002 shipped under different delivery categories by different types of shipping agencies.
1003 Under Open-edi, typification is strongly linked to the concept of *Scenarios* which are
1004 formal specifications of specific classes of business transactions designed for
1005 reusability. As discussed in Clause 6, connected type images also result many
1006 times in control artifacts such as the rules embodied in internal and external Open-
1007 edi constraints. Such constraints supply pre- and post-conditions on state machine
1008 transitions.

1009

1010

1011

1012 **5.4 Locations and Claims**

1013

1014 Figure 14 illustrates two non-normative additions to the basic Open-edi ontological
1015 framework.

1016

- 1017 • A *Business Location* designates the place where an Economic Event
1018 occurs if such information is needed. Locations also indicate the
1019 targeted delivery points for Economic Commitments. *Location Types*
1020 indicate instances like an approved kind of delivery warehouse or
1021 loading dock.
- 1022 • An *Economic Claim* is an optional materialization of a temporal
1023 imbalance in a duality relationship where an Economic Event has
1024 occurred without its required correspondence to another Economic
1025 Event. An initial Economic Event *materializes* the claim, while the
1026 requiring Economic Event *settles* it. A common EDI document
1027 example of a claim is an invoice.

1028

1029 **5.5 Adding Commitments to Economic Exchanges**

1030

1031 In the Open-edi ontology, a Business Transaction pertains to the exchange of
1032 something of value as illustrated in the delivery-payment example of Figure 7. An
1033 additional key property of an Open-edi Business Transaction is that it involves
1034 commitment exchange, a circumstance modelled on top of the delivery-payment
1035 example in Figure 10. In economic terms however, commitments do not occur in
1036 isolation because partners simply do not agree to value exchanges without
1037 reciprocation. As illustrated at the top of Figure 15, commitments are bundled in
1038 contracts between persons where, for example, a commitment to deliver some
1039 product is reciprocated by a commitment to pay cash.

1040

1041 In Figure 16, the ex ante nature of commitments is illustrated further. At a minimum,
1042 an Open-edi economic commitment should specify the type of economic resource
1043 expected in the fulfilling economic event. For example, a catalog order chooses
1044 from a product list for delivery. Additionally, the economic commitment often will
1045 specify:

1046

- 1047 • the type of event to fulfil it (such as an expedited delivery or a purchase
1048 under wholesale pricing), and
- 1049 • the economic roles needed in the eventual exchange (such as a buyer, a
1050 seller, a seller agent, and a third-party escrow).

1051

1052 Economic Commitments may less commonly specify location types like an
1053 approved class of warehouse.

1054

1055 **5.6 Business Transactions with Contracts**

1056

1057 Figure 17 adds Economic Commitment structures to the basic notion of an
1058 economic exchange. As mentioned previously, commitment is one of the defining
1059 features of Open-edi, so these structures are extremely important ontological
1060 components.

1061

- 1062 • An *Economic Commitment* is a promise to execute an Economic
1063 Event at some point in the future. The specification of an
1064 Economic Commitment may involve relationships with four type-
1065 level classes: Economic Resource Type, Location Type,
1066 Economic Event Type, and Economic Role. Economic
1067 Commitments may also have relationships with Economic
1068 Resource (*reserves*), Person (*involves*), and Business Location
1069 (*target*).
- 1070 • A *fulfills* relationship is an association between an Economic
1071 Commitment and the Economic Event that executes that
1072 commitment.
- 1073 • A *reciprocal* relationship is an association between Economic

- 1074 Commitments that each in turn individually fulfills compensating
1075 Economic Events.
- 1076 • An *Economic Contract* is a bundle of reciprocating Commitments
1077 wherein two Parties agree to a future schedule of exchanges with
1078 compensating Economic Events. An *Agreement* is similar to a
1079 Contract, but it is not legally enforceable.
 - 1080 • An *establishment* relationship is an association between an
1081 Economic Contract and its pair of reciprocal Commitments.

1082

1083 Figure 18 illustrates the full addition of the “commitments to type specification” by
1084 combining Figures 16 and 17. Additionally, it extends the concept of a *Bilateral*
1085 *Transaction* to that of a *Mediated Transaction* by including the previously-defined
1086 *Third Party* subtype of *Person* as an essential ingredient of mediated
1087 collaborations. Figure 18 also indicates the essential roles of *Regulators* who are
1088 Persons who constrain business transactions.

1089

1090

1091 **5.7 Typifying Agreements and Business Transactions**

1092

1093 Figure 19 and Figure 20 illustrate typification of Agreements and Business
1094 Transactions.

- 1095 • All Business Transactions are set in both *Defined Markets* and
1096 *Undefined Markets*, both of which are *overseen* by various
1097 *Jurisdictions*.
- 1098 • Business Transactions are classed in different kinds of *Scenarios*
1099 such as the 2x2x2 factoring shown in the cloud at the bottom of
1100 Figure 19.
- 1101 • An *Agreement* can be decomposed into classes like
1102 *Leases/Rentals*, *Service Agreements*, *Consignments*, and
1103 *Purchases*. Agreements have *Pricing Methods* like reverse
1104 auctions, open and closed bids, and individual quotes. These
1105 methods can in turn be typified into classes (Pricing) like bid,
1106 auction, or matching. These are all illustrated in Figure 20.

1107

1108 The modelling specifications illustrated in Figure 4 through Figure 20 give specific
1109 conceptual definition to many of the Open-edi Business Transaction terms used in
1110 part 1 of 15944. In the following clause, the behavioural use of these components is
1111 explained with explicit reference to the Open-edi notion of Business Transaction
1112 *phases*. According to 15944-1, a collaboration proceeds through the stages of
1113 planning, identification, negotiation, actualization, and post-actualization, and an
1114 ontologically-based state machine model of this progress is explained there.

1115 **6. The Procedural Component of an OeBTO – Business Transaction State**
1116 **Machines**

1117
1118 An ontology has a declarative component – which specifies the categories into
1119 which collaboration data exchanged among Persons in a business transaction may
1120 be slotted – a procedural component – which specifies how that data is to be used
1121 in deriving conclusions -- and a constraint component – which specifies the
1122 business rules for both data and procedures. In an operational Open-edi business
1123 transaction ontology, the various declarative components specified in Clause 5 – for
1124 example all of the classes illustrated in Figure 18 – become defined as *Business*
1125 *Transaction Entity Types (BTET)*. BTETs represent the abstract specification of
1126 *Business Transaction Entities (BTE)*, detailing their recommended characteristics,
1127 their recommended methods, and their recommended life-cycle states. Additionally,
1128 a business transaction entity type will usually specify the types of business events
1129 that cause a BTE of this type to proceed through its different states as the business
1130 transaction itself progresses through its own phases of planning, identification,
1131 negotiation, actualization, and post-actualization. A *BTE* thus is a particular real
1132 instance of a *business transaction entity type*. For procedural materialization of
1133 conclusions, a BTE is the computable representation of any real world *entity* that
1134 participates, occurs, or is materialized during a particular *business transaction*.

1135
1136

1137 **6.1 Relating Ontological Components to the Open-edi Business Transaction**
1138 **Phases**

1139
1140 From Open-edi 15944-1, Figure 21 enumerates the five identified phases of an
1141 Open-edi *Business Transaction*. This phase specification is one of the major
1142 contributions of that standard. Figure 22 adds the definition of Business
1143 Transaction Phases to the OeBTO declarative primitives for a bilateral collaboration
1144 as specified in Clause 5. This figure also specifies that these phases have *Business*
1145 *Events* as components, illustrating the behavioural progress through each phase as
1146 marked by collaborative activities. A Business Event is defined as *an occurrence in*
1147 *time in collaboration space that persons wish to plan, control, monitor, or evaluate*.
1148 Business Events are the fuel that drives a business transaction state machine, as
1149 they progress that dynamic representation through its five phases by changing the
1150 states of the ontological components illustrated in Figure 22. Additionally, Business
1151 Events have component structures as illustrated by the recursive relationships in
1152 Figure 22, and this facilitates the modeling of actions in business collaboration
1153 space at whatever level of granularity is needed. Business Event components can
1154 drive the state of a higher-level Business Event to completion, and that higher level
1155 component may then effect a state change in one of the business transaction
1156 entities for a particular transaction. Figure 22 illustrates the addition of Business
1157 Transaction Phases and Business Events to the basic Open-edi collaboration
1158 ontology.

1159
1160

Figure 23 illustrates the approximate correspondence of the Open-edi Business

1161 Transaction phases with the categories of ontological components defined in
1162 Clause 5.

- 1163 • Planning and Identification involve Business Events wherein
1164 potential buyers and sellers identify each other by matching on
1165 proposed types of resources to be exchanged and their actual
1166 trading partners.
- 1167 • Negotiation involves Business Events wherein linked business
1168 partners cooperate on the abstract specification of their proposed
1169 exchange (its type of resources, events, and roles as stipulated in
1170 a contract).
- 1171 • Actualization and Post-Actualization involve Business Events that
1172 aggregate to the performance of actual resource transfers
1173 (Economic Events) between the buyer and seller.

1174
1175 Business Events are the specific activities that mark the explicit states that trading
1176 partners expose to each other as they complete an exchange. For example,
1177 supplying a quote on a listed product during negotiation may progress an Economic
1178 Commitment from status (or state) “unspecified” to “proposed” while simultaneously
1179 marking a Resource-Type and an Event-Type as “specified.” If this Business Event
1180 of supplying a quote was followed by a quote acceptance and then a payment terms
1181 acceptance, an Economic Contract might move into status “in-force” and then the
1182 entire Negotiation Phase might move into state “completed.” This completed
1183 negotiation would keep the entire Business Transaction in state “in progress,”
1184 whereas an unsuccessful negotiation might have moved the overall Business
1185 Transaction into state “aborted” or state “suspended.”

1186
1187 Figure 24 portrays the individual phases of a Business Transaction and the
1188 targeted object states that would signal to each business partner that a particular
1189 phase was now complete.

- 1190
1191 • Planning is complete when both trading partners have formulated an
1192 abstract vision of an exchange. This involves moving certain Economic
1193 Resource Types into an identified state.
- 1194 • Identification is complete when the corresponding partners have been
1195 identified along with the planned resource types. This establishes a 1-to-1
1196 linkage.
- 1197 • Negotiation is complete when the abstract specification of Economic
1198 Commitments in a full contract is complete.
- 1199 • Actualization is complete when the requiring Economic Events are both
1200 complete, thus marking the full exchange.
- 1201 • Post-Actualization is complete when the possible warranty (or similar post-
1202 exchange exception condition) component of an Economic Resource is
1203 invoked, and the conditions of the exchange reach their final values.

1204
1205 Figure 25 illustrates how the declarative ontological components of Open-edi
1206 (referred to here as Business Transaction Entity Types) can be augmented to

1207 account for state machine mechanics. Each ontological component is envisioned
1208 as a possible Business Transaction Entity with a defined Business Transaction
1209 Entity Lifecycle consisting of multiple Business Transaction Entity States. The
1210 transition to these states is effected by the occurrence of a Business Event.

1211

1212 **6.2 An Example State Machine**

1213

1214 Figure 26 illustrates some example states that could be defined for some of the
1215 Open-edi Ontology components defined thus far. In a full ontological
1216 specification, all of the business transaction entity types defined in this document
1217 would be given fully-enumerated lifecycles of object states (as specified in Figure
1218 25). However, these would change from one business context to another, so the
1219 exposition here is limited to this non-normative example.

1220

1221 Figure 27 shows the ontology components of a Business Transaction, as
1222 augmented to include the example states from Figure 26 for four of the business
1223 objects: Business Transaction, Economic Claim, Business Transaction Phase
1224 (e.g., Negotiation), and Economic Resource Type. A full state machine
1225 representation would have these cycles defined for every object on the diagram.

1226

1227 Figure 28 lists an example set of business events involved in an example
1228 business transaction. These 13 Business Events represent a full collaboration
1229 between an example buyer and seller, as it proceeds through the Open-edi
1230 phases. Again, each Business Event might cause multiple state changes. For
1231 example, the tenth action -- Buyer sends *ReceivingReport* to Seller when
1232 inspected goods are accepted -- would cause the Economic Event of *Shipment* to
1233 move into its *Completed* state, and the Economic Resource of *Inventory* to move
1234 into its *Transferred* state.

1235

1236 A UML state machine diagram is the best formal specification of dynamic object
1237 behavior with state changes. Such a specification is illustrated in Figure 29 for
1238 the *Business Entity Type* "Economic Resource Type" as it moves through the
1239 example collaboration.

1240

- 1241 • The Economic Resource Type (for example a type of inventory) would
1242 become a *Candidate* when the Publish-Catalog business event occurs,
1243 moving from its initial undefined state (black dot).
- 1244 • The Send-Catalog-Request event would then move the inventory into
1245 state *Planned*.
- 1246 • The Accept-Availability-And-Price-Request would cause the inventory to
1247 become *Identified*. This same event would move the Partners into state
1248 *Identified* and the Identification Phase of the Business Transaction into
1249 state *Complete* (not shown in Figure 29).
- 1250 • The Send-Offer event would shift the example inventory into its *Proposed*
1251 state.
- 1252 • The Accept-Offer would cause the Economic Resource Type to become

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Specified.

- And finally, , a Send-Shipping-Notice action would cause the resource type to move to an *Actualization* state (end of object life cycle).⁵

To summarize the state machine presentation, it is necessary to understand how the definitions of Clause 5 and Clause 6 work together.

- Clause 4 defined the *declarative* components of the Open-edi ontology. This is a specification of the primitive classes as they model the components of a business transaction. These primitive classes become candidates for *business transaction entity types*.
- Clause 6 defined the *procedural* components of the Open-edi ontology. This illustrated the dynamic mechanics of tracking a business collaboration through each of its five phases using state machine mechanics.

⁵ In actuality, this state machine example for Economic Inventory Type is slightly more complicated as the individual state changes would need to be tracked through a UML association class between the Economic Inventory Type and the Business Transaction.

1271 **7. The Constraint Component of an OeBTO – Incorporating Business Rules**
1272 **into Business Transactions**

1273

1274 **7.1 Business Rules and Open-edi Constraints**

1275

1276 Business rules specifying computational procedures, approved sequences of
1277 actions, valid inferences, and effective control monitoring govern the day-to-day
1278 operations of business enterprises. A useful definition of a “business rule” from
1279 Eriksson and Penker is:

1280

1281 ... a statement that can control or affect the execution of a business
1282 process as well as the structure of the resources in a business. The
1283 statement specifies a condition that must be upheld, or a condition that
1284 controls which activity should follow next. It can express a business goal,
1285 specify the way a process should execute, detail the conditions of a
1286 relationship, or constrain the behavior of a resource.⁶

1287

1288 In the database world somewhat synonymously, “constraints” are defined as rules
1289 governing the integrity of data that prevent a database from moving from one
1290 representation state to another without proper validation, and in the most simple
1291 ontological case, their function is exactly congruous with the business rules
1292 definition given above. Database integrity constraints are also commonly
1293 referred to as assertions.⁷

1294

1295 In *Operational aspects of Open-edi for implementation* (part 1 of 15944), a
1296 **constraint** is defined as “a rule, explicitly stated, that prescribes, limits, governs,
1297 or specifies any aspect of a *business transaction*.” That same standard
1298 differentiates those constraints that are self imposed by the trading parties
1299 (internal) from those constraints created by law, regulation, orders, treaties,
1300 conventions, or similar instruments (external):

1301

1302 **internal constraint:** a constraint which forms part of the *commitment(s)*
1303 mutually agreed to among the parties to a *business transaction*

1304

1305 **external constraint:** a constraint which takes precedence over *internal*
1306 *constraints* in a *business transaction*, i.e., is external to those agreed upon by
1307 the parties to a *business transaction*

1308

1309 Open-edi further divides the category of external constraints into (1) those that
1310 are common and horizontal in nature as introduced by the additional presence in
1311 a business transaction of a “regulator” as a third subtype of Person representing
1312 “public administration,” and (2) those that are more sectorial in nature (involving
1313 standard rules both across many sectors and across just one sector). Open-edi

6 Hans-Erik Eriksson and Magnus Penker (2000) *Business Modeling with UML*, John Wiley & Sons, New York, p. 81.

7 D.C. Tsichritzis and F.H. Lochovsky (1982). *Data Models*, Prentice-Hall, Englewood Cliffs, NJ., chap. 3.

1314 differentiates these classes of constraints in order to provide summaries of
1315 complex bundles of rules for scenario registration. For example, the simplest
1316 constraint bundle for a scenario could aggregate only internal constraints, the
1317 next most complex could add horizontal external constraints, etc.

1318

1319 In the OeBTO, constraints encapsulating business rules constitute the third major
1320 representation component. The first component was the declarative specification
1321 of domain classes and associations in Clause 5, while the second component
1322 was the procedural aspects associated with business transaction state machines
1323 explained in Clause 6.

1324

1325

1326 **7.2 OeBTO Constraint Examples**

1327

1328 Constraints may be expressed informally in natural language, such as the
1329 following accounting rule for separation of duties as applied to the class diagram
1330 of Figure 9:

1331

1332 *“the Person who fills the accountability role in an Economic Event*
1333 *that involves a certain Economic Resource should not be the*
1334 *same Person who has a custody relationship with that Economic*
1335 *Resource”*

1336

1337 The need for this constraint to a business transaction could be derived for
1338 example from a sectorial application (an OeBTO external constraint) of the 2002
1339 USA Sarbanes-Oxley internal control legislation.

1340

1341 Constraints may also be expressed more formally with the Object Constraint
1342 Language (OCL) of the UML. For example, a state sales tax rule for Michigan
1343 (another sectorial external constraint) on merchandise orders (a subtype of
1344 Economic Contract) could be specified as 6% of the gross amount of the order:

1345

1346 context Order inv michiganSalesTaxCalculation
1347 salesTax = grossAmount * .06

1348

1349 Such a constraint could be placed in curly brackets on a UML class diagram next
1350 to the class definition for order (for example, a more specific form of Figure 18),
1351 and it then becomes an invariant (inv) or a condition that must be true for all
1352 objects of that class.

1353

1354 According to both Odell (1998) and Eriksson and Penker (2000), constraints may
1355 be of two general behavioral kinds⁸:

1356

⁸ James Odell (1998) *Advanced Object-Oriented Analysis and Design Using UML*. Sigs Books, New York, and Hans-Erik Eriksson and Magnus Penker (2000) *Business Modeling with UML*, John Wiley & Sons, New York

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- Those that define how knowledge in one form may be inferred or derived from another form. Examples of this constraint category might be the Michigan sales tax calculation shown above. Another example might be a constraint that designates a scheduled shipment as "hazardous" if it exceeds a designated weight threshold of goods (economic resources) typed as "dangerous if unpackaged" in an inheritance taxonomy.
 - Those that "constrain either the possible structure or the behavior of objects or processes, that is, the way objects are related to each other or the way objects or process state changes may occur."⁹ An especially prominent illustration for the OeBTO of this class of constraints are rules that define pre- and postconditions for the types of state changes described in Clause 6. For example in Figure 29, the state machine diagram makes it clear that for EconomicResourceType to achieve its "proposed" state, it has a precondition of being in state "identified" and a postcondition of state "specified" and that these transitions are effected by the business events shown. These same types of rules can be specified as constraints in OCL and portrayed on UML class diagrams.

1375 Both derivation business rules and constraint business rules are important to

1376 effective business operation in collaboration space, so their characterization in

1377 the Open-edi Business Transaction Ontology is an important third step in insuring

1378 interoperability and semantic integrity. To the extent that the declarative and

1379 procedural components of an ontology are specified correctly, the parties to a

1380 business transaction are given computable methods for ensuring compliance

1381 with both internal and external constraints.

1382

1383

1384 **7.3 Summary**

1385

1386 There is certainly now a critical opportunity for developing coherence in

1387 worldwide standards for business level definitions of economic phenomena.

1388 Open-edi, especially in its prior work of 15944-1, has standardized much of the

1389 technical and economic environment for economic exchanges, and the field of

1390 ontology provides an extended opportunity for unifying and coordinating that

1391 work. Part 4 of 15944 aims to provide that unity with an ontological analysis of

1392 the declarative, procedural, and constraint components of Open-edi. Certainly,

1393 the majority of the work in this document concentrates on the declarative

1394 components of the OeBTO – those data classes that model the fundamental

1395 categories of economic endeavors in collaboration space and the relationships

1396 that exist among those categories. This declarative emphasis is reasoned and

1397 deliberate. As noted by John Sowa¹⁰, conceptual progress in a specialized

1398 domain is usually marked by an increasing percentage of the knowledge in that

9 -Erik Eriksson and Magnus Penker (2000) *Business Modeling with UML*, John Wiley & Sons, New York, p. 154

10 John Sowa (1984). *Conceptual structures: Information Processing in Mind and Machine*. Addison-Wesley, Reading, MA. P. 24.

1399 field being embedded in its declarative components. As ad hoc procedures and
1400 constraints become more structured and predictable, they lead naturally to better
1401 theoretical and conceptual structures.

1402

1403 In concert, the declarative, procedural, and constraint components of the Open-
1404 edi ontology provide a definitive specification that is formal, explicit, and
1405 conceptual. An ontological foundation is one of the key components of that
1406 coherence.

1407

1408

1409

1410 **8.0 Informative Annex – REA model background¹¹**

1411

1412 **8.1 REA (Resource-Event-Agent) Ontology Introduction**

1413

1414 Ontology, according to the most generally accepted e-commerce definition of that
1415 word, is a “specification of a conceptualization.”¹² The REA (Resource-Event-
1416 Agent) ontology is a specification of the declarative semantics involved in a
1417 business process. The theory behind REA came initially from the field of
1418 accounting where REA was first introduced, but its components clearly have
1419 microeconomic origins with specific ties in many instances to the use of
1420 economic definitions in the practice of building enterprise-wide information
1421 systems. In UN/CEFACT work, all of the REA ontology definitions are applied to
1422 the collaborative space between enterprises where market exchanges occur in
1423 closely synchronized fashion among two or more trading partners.

1424

1425 In its most simple form without a high degree of precision, REA can be portrayed
1426 as a UML class diagram with associations and generalizations relating the object
1427 classes. The intent of this appendix is to display REA simply and to explain its
1428 basic rationale. To do so, the appendix will use a set of figures labeled A-1
1429 through A-5. The most advanced of the UML diagrams (A-3) is a good overall
1430 guide to the BRV semantics, given both here and in the Unified Modeling
1431 Methodology (UMM) of UN/CEFACT. This appendix will also list a series of
1432 archival publications that are freely available at the following website for readers
1433 who desire more detailed explanations (<http://www.msu.edu/user/mccarth4/rea-ontology/index.htm>).

1434

1435 **8.2 The Basic REA Ontology**

1436

1437
1438 The basic REA model was first published in the July 1982 issue of *The*
1439 *Accounting Review*¹³, the most prominent, most reliable, and most tightly
1440 controlled outlet for theoretical-based accounting work in the world. Its basic
1441 premises have withstood all theoretical challenges in the 20 years since, and its
1442 components are used extensively in a variety of educational, practical, and
1443 theoretical contexts. The REA model work was given the first (and thus far only)
1444 *Seminal Contribution to the Accounting Information Systems Literature Award* in
1445 1996 by the American Accounting Association (AAA), and in 2003, its use as a
1446 model for teaching enterprise information systems was awarded the *Innovation in*
1447 *Accounting Education Award*, also from the AAA. There are a number of
1448 textbooks in worldwide use that feature REA as a pattern-oriented teaching
1449 framework, the most prominent of which is the 2004 Dunn, Hollander, and

11 This Annex with some modifications has been adapted from the *UN/CEFACT Simple Guide to the UMM*

12 Thomas Gruber (1993) “A Translation Approach to Portable Ontologies,” *Knowledge Acquisition*, pp. 199-220.

13 William E. McCarthy (1982.) “The REA Accounting Model: A Generalized Framework for Accounting Systems in A Shared Data Environment.” *The Accounting Review* (July), pp. 554-578

1450 Cherrington book¹⁴.

1451

1452 Figure A-1 **Error! Reference source not found.** illustrates the basic class
1453 structure of REA ontology. The left-to-right configuration of economic Resources,
1454 economic Events, and economic Agents (renamed in UMM as “Partner”) in a
1455 typical business collaboration pattern is the source of the model’s REA name.

1456

1457 A successful business collaboration involves first and foremost two types of
1458 Economic Events, each of which details the Economic Resources involved in an
1459 exchange between two Trading Partners. For example, a Supplier (Trading
1460 Partner) transfers ownership of an Automobile (Economic Resource) to a
1461 Customer (Trading Partner) in return for which (duality association) the Customer
1462 will provide Money (Economic Resource) to the Supplier. There are two mirror-
1463 image instantiations of the object pattern shown in Figure A-1 where one transfer
1464 represents the legal or economic consideration given for the other.

1465

1466 The declarative semantics shown here are central to all trading relationships.
1467 Economic Resources are objects that have value and are under the control of
1468 one of the two collaborative agents. Trading partners always expect required
1469 transfers of resources when they engage in commerce. Hence, **Error!**
1470 **Reference source not found.** Figure A-1 is a pattern for all economic
1471 exchanges.¹⁵

1472

1473 **8.3 Adding Commitments to the Basic Exchange Ontology**

1474

1475 In electronic commerce, the actual trading phase of an exchange is
1476 accommodated well by the object structure shown in Figure A-1 **Error!**
1477 **Reference source not found.** However, trading partners in long-term
1478 relationships need more trusted and predictable structures where both parties
1479 contract for their exchange behavior in advance. The REA ontology
1480 accommodates this expansion with the addition of the classes shown as
1481 Economic Commitments, Economic Contract, and Agreement in Figure A-2.

1482

1483 A Commitment is a promise by a Trading Partner to initiate an Economic Event in
1484 the future. Performing the Economic Events fulfills that Commitment.

1485 Commitments should always be reciprocated by the other Trading Partner who
1486 commits to initiate another type of Economic Event in return. An Economic
1487 Contract is a bundle of reciprocating commitments between Trading Partners
1488 who bind themselves to one or more economic exchanges in the future. A
1489 contract is a subtype of the more general object class called Agreement, and
1490 Agreements can regulate other Agreements.

14 C. Dunn, J.O. Cherrington, and A.S. Hollander (2005) *Enterprise Information Systems: A Pattern-Based Approach*, McGraw-Hill Irwin, Boston, MA

15 G. Geerts and W.E. McCarthy (1999). “An Accounting Object Infrastructure For Knowledge-Based Enterprise Models.” *IEEE Intelligent Systems & Their Applications* (July August 1999), pp. 89-94

1491

1492 In the case of the automobile-for-money exchanges discussed in the prior
1493 section, Commitments would involve the Customer agreeing to accept delivery of
1494 an Automobile on a certain date in return for which he or she would be
1495 contractually obligated to making a series of Cash payments to the Supplier for
1496 that purchase.

1497

1498 In the bottom part of Figure A-2, two additional objects of the REA ontology are
1499 illustrated: Claims and Locations.

1500

1501 • Materialization of Claims is sometimes needed when Trading Partners
1502 insist on documentation of partially completed exchanges (for example,
1503 when a Customer takes possession of an Automobile before paying for it
1504 in full). If needed, Claims can be instantiated by documents like invoices
1505 or by accounting artifacts like accounts-receivable. Their inclusion here is
1506 more a matter of business custom than ontological completeness.

1507 • A Location is another object that is sometimes needed to fill out the
1508 specification for a full economic transfer. Locations simply identify the
1509 place where Economic Events take place.

1510 The economic and ontological foundations of commitments are explained more
1511 completely by Geerts and McCarthy.¹⁶

1512

1513 **8.4 Adding Types to the Basic REA Exchange Ontology**

1514

1515 The object pattern portrayed in Figure A-2 is primarily descriptive in the sense
1516 that it illustrates what actually occurred in an economic exchange or what has
1517 been committed to. In the UMM, these descriptive components have been
1518 augmented by prescriptive components that allow the specification of control
1519 policies or collaboration patterns. These prescriptive components are enabled by
1520 the inclusion of type images of the basic descriptive objects¹⁷. The class diagram
1521 of Figure A-3 shows these additions.

1522

1523 The addition of Types to the REA model proceeds in two stages:

1524

1525 • The three base descriptive classes – Economic Resource, Economic
1526 Event, and Partner (Economic Agent) – have classes added for their types.
1527 These new classes are connected to the descriptive objects by *typifies*
1528 associations. An example of a Resource Type could be different models of

16 G. Geerts and W.E. McCarthy (2000) "The Ontological Foundation of REA Enterprise Information Systems," paper presented to the Annual Meeting of The American Accounting Association, August 2000.

17 G. Geerts and W.E. McCarthy (2002) "An Ontological Analysis of the Primitives of the Extended-REA Enterprise Information Architecture," The International Journal of Accounting Information Systems (Vol. 3), pp. 1-16.

1529 automobiles. An example of Economic Event Type could be the classes of
1530 retail transaction and wholesale transactions, each with different pricing
1531 structures. An example of Partner Type could be different classes of
1532 employees, each type with separate training requirements. Additionally, the
1533 class Location is also typified. An example of Location Type might be
1534 different types of loading docks with different sizes and stress capability
1535 levels.

- 1536 • The full design of the Economic Commitment would necessitate
1537 associations between the commitment and each of the new type-level
1538 objects. These are illustrated in the figure with *specifics* associations.

1539

1540 In addition to these two groups of additions, there are other REA associations in
1541 the UMM that are not illustrated here in an effort to minimize diagram complexity.
1542 These include:

1543

- 1544 • Contract – responsible -- Partner
- 1545 • Partner -- participates – Agreement
- 1546 • Economic Commitment – reserves – Economic Resource

1547

1548 And finally with regard to Figure A-3, the partial integration of the elements of the
1549 REA ontology with the components of the UMM business collaboration
1550 framework is illustrated by showing the class for Business Collaboration (with
1551 dotted lines) and some of its associations with REA classes (also illustrated with
1552 dotted lines). Outside of its use with the UMM and the attendant specifications,
1553 the REA ontology has a three-level architecture that is explained by Geerts and
1554 McCarthy.¹⁸ In the UMM, this three-level architecture is effected by the
1555 integration of REA components within the business collaboration framework and
1556 by the connection of the Business Requirements View (BRV) to the Business
1557 Domain View (BDV) above it and the Business Transactions View (BTV) below it.

1558

1559

1560 **8.5 The Suitability of the REA Ontology within the Open-edi Model**

1561

1562 The REA ontology is well known and well used throughout the field of accounting
1563 and to a lesser extent throughout the field of enterprise computing in general. It
1564 is the best example of a business domain ontology in existence today, and its
1565 measures well against the most commonly cited “ontology quality” criteria as
1566 proposed by Gomez-Perez.¹⁹ Her functional criteria and the REA explanation of

18 G. Geerts and W.E. McCarthy (2001). “Using Object Templates from the REA Accounting Model to Engineer Business Processes and Tasks,” *The Review of Business Information Systems*, vol. 5, no. 4, pp. 89-108.

19 Gomez-Perez, A. 1998. “Knowledge sharing and reuse,” in J. Liebowitz, ed., *The Handbook of Applied Expert Systems*, CRC Press.

1567 their applicability are portrayed in Figure A-4.
1568 REA and Open-edi also fit very well together, as do REA and the Business
1569 Requirements View of the UN/CEFACT metamodel. Figure A-5 illustrates how
1570 these three systems correspond to each other on some very important points of
1571 emphasis.

1572

1573 It is also the case that many of the best-developed ideas of Open-edi have
1574 themselves led to improvements in the published presentations of the REA
1575 ontology. For example:

1576

- 1577 • The extremely well-developed logic of Persons and its subtypes in Open-
1578 edi has led to significant additions in the REA ontology to the concepts of
1579 Economic Agent and (especially) Economic Agent Type.
- 1580 • The concepts of binary and mediated collaborations in Open-edi has led to
1581 much closer examination in REA work to the notion that all multi-party
1582 transactions can, under conditions of general equilibrium, perfect
1583 knowledge, and monetary liquidity, be decomposed into binary
1584 transactions.
- 1585 • The notion of the independent view of business collaborations has
1586 confirmed ontological input from UN/CEFACT and other groups
1587 concerning this important distinction.
- 1588 • The incorporation of business rules as Open-edi constraints has enabled
1589 the inclusion of important inferencing and control mechanisms within an
1590 REA-typed collaboration.
- 1591 • And finally and clearly most significant of all, the 5-phase process model
1592 of Open-edi has been adopted directly within REA to solve the business
1593 process state machine problems within that ontology. Previously, REA
1594 had no criteria to serialize the occurrence of business events or workflow.
1595 The state machine model of Open-edi, illustrated in this document in
1596 Clause 6, has solved this problem in an elegant fashion.

1597

1598 **9.0 REFERENCES**

1599

1600 Geerts, G. and W.E. McCarthy. 1999. "An Accounting Object Infrastructure For
1601 Knowledge-Based Enterprise Models." *IEEE Intelligent Systems & Their Applications* (July
1602 August 1999), pp. 89-94.

1603

1604 Geerts, G. and W.E. McCarthy. 2001. "An Ontological Analysis of the Primitives of the
1605 Extended-REA Enterprise Information Architecture," *The International Journal of*
1606 *Accounting Information Systems*

1607

1608 Geerts, G. and W.E. McCarthy. 2005. "The Ontological Foundation of REA Enterprise
1609 Information Systems"

1610

1611 Gomez-Perez, A. 1998. "Knowledge sharing and reuse," in J. Liebowitz, ed., *The*
1612 *Handbook of Applied Expert Systems*, CRC Press.

1613

1614 Gruber, T. 1993. "A Translation Approach to Portable Ontologies," *Knowledge Acquisition*,
1615 pp. 199-220.

1616

1617 Ijiri, Y. 1975. *Theory of Accounting Measurement*, American Accounting Association.

1618

1619 McCarthy, W.E. 1979. An Entity-Relationship View Of Accounting Models. *The Accounting*
1620 *Review* (October): 667-86.

1621

1622 McCarthy, W.E. 1982. "The REA Accounting Model: A Generalized Framework for
1623 Accounting Systems in A Shared Data Environment." *The Accounting Review* (July), pp.
1624 554-578.

1625

1626 Odell, J.J. 1998. *Advanced Object-Oriented Analysis & Design Using UML*, Cambridge
1627 University Press.

1628

1629 Porter, M.E. 1985. *Competitive Advantage*. The Free Press.

1630

1631 Sakai, H. 1981. "A Method for Defining Information Structures and Transactions In
1632 Conceptual Schema Design," *Proceedings of the Seventh International Conference on*
1633 *Very Large Data Bases*, pp. 225-34.

1634

1635 Smith, J.M. and D.C.P. Smith. 1977. "Database abstractions: Aggregation and
1636 Generalization," *ACM Transactions on Database Systems* (June): 105-133.

1637

1638 Sowa, J. 1999. *Knowledge Representation: Logical, Philosophical, and Computational*
1639 *Foundations*, Brooks/Cole Publishing, Pacific Grove, CA.

1640

1641 Tsichritzis, D.C. and F.H. Lochovsky. 1982. *Data Models*, Prentice-Hall, Englewood Cliffs,
1642 NJ.

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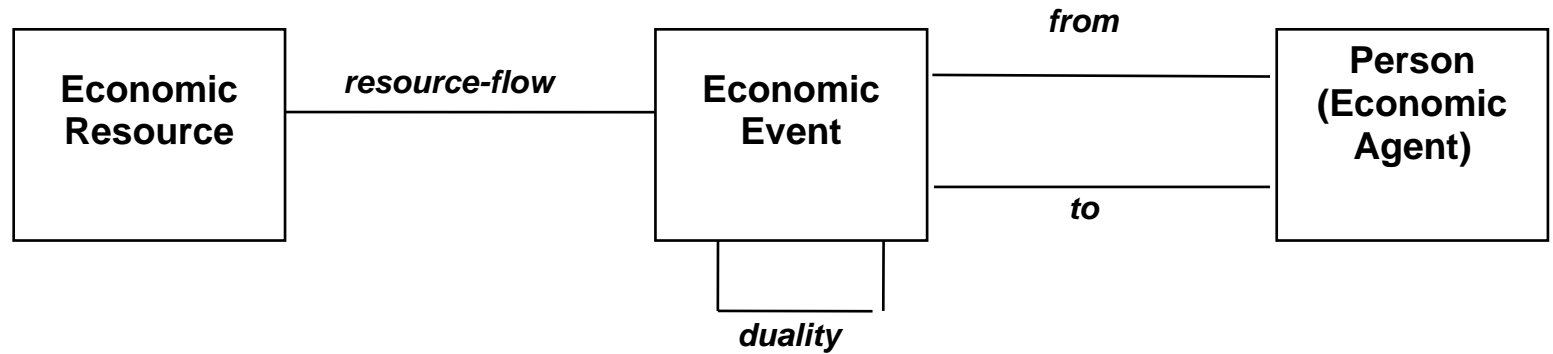


Figure 1 – Basic Economic Primitives of the ISO Open-edi Ontology

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Collaboration Perspective: **Trading Partner** vs. Independent

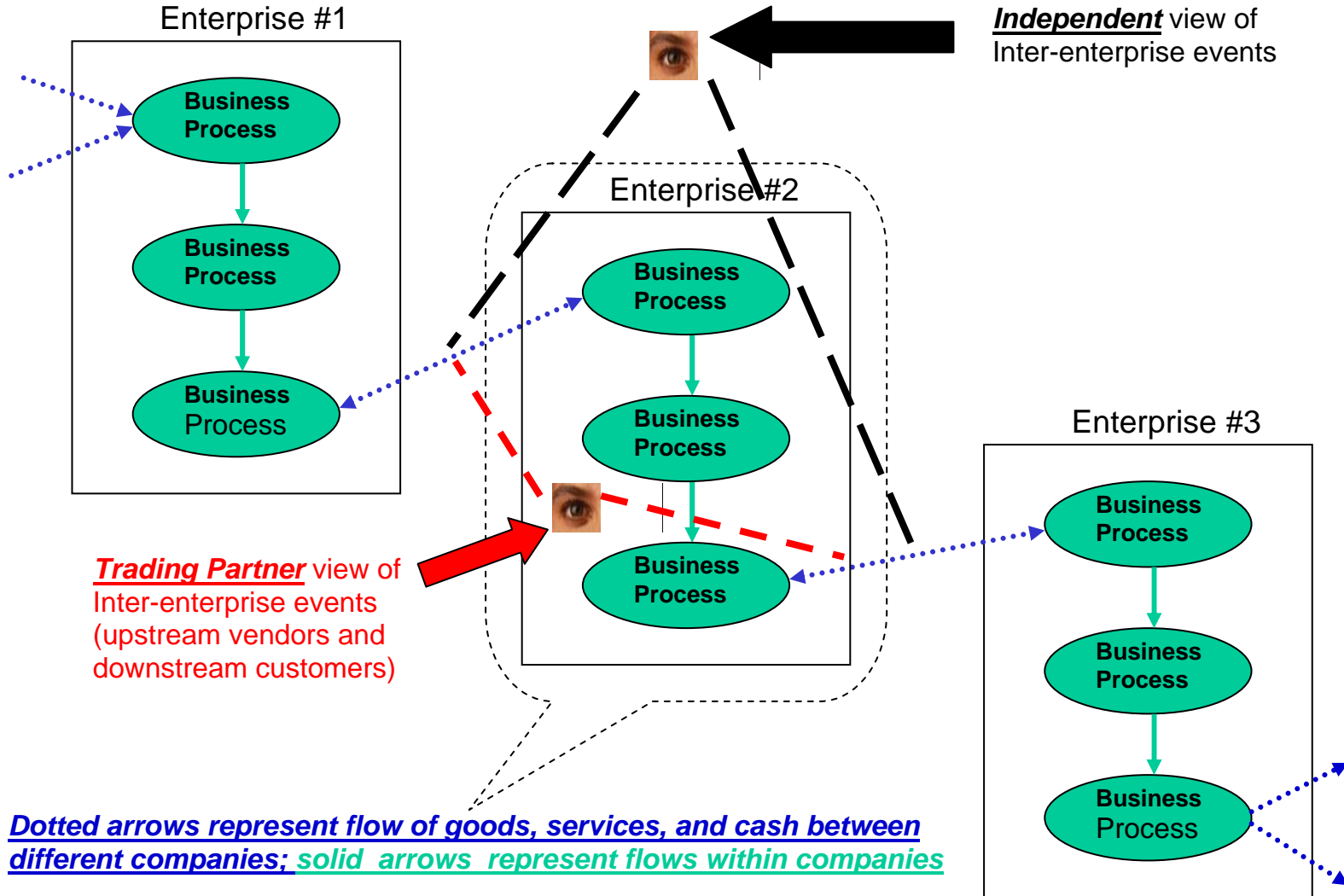


Figure 2 – Different Views of Business Collaboration

Japan expert contribution to 15944-4, 22 Oct 2001, Victoria BC ,

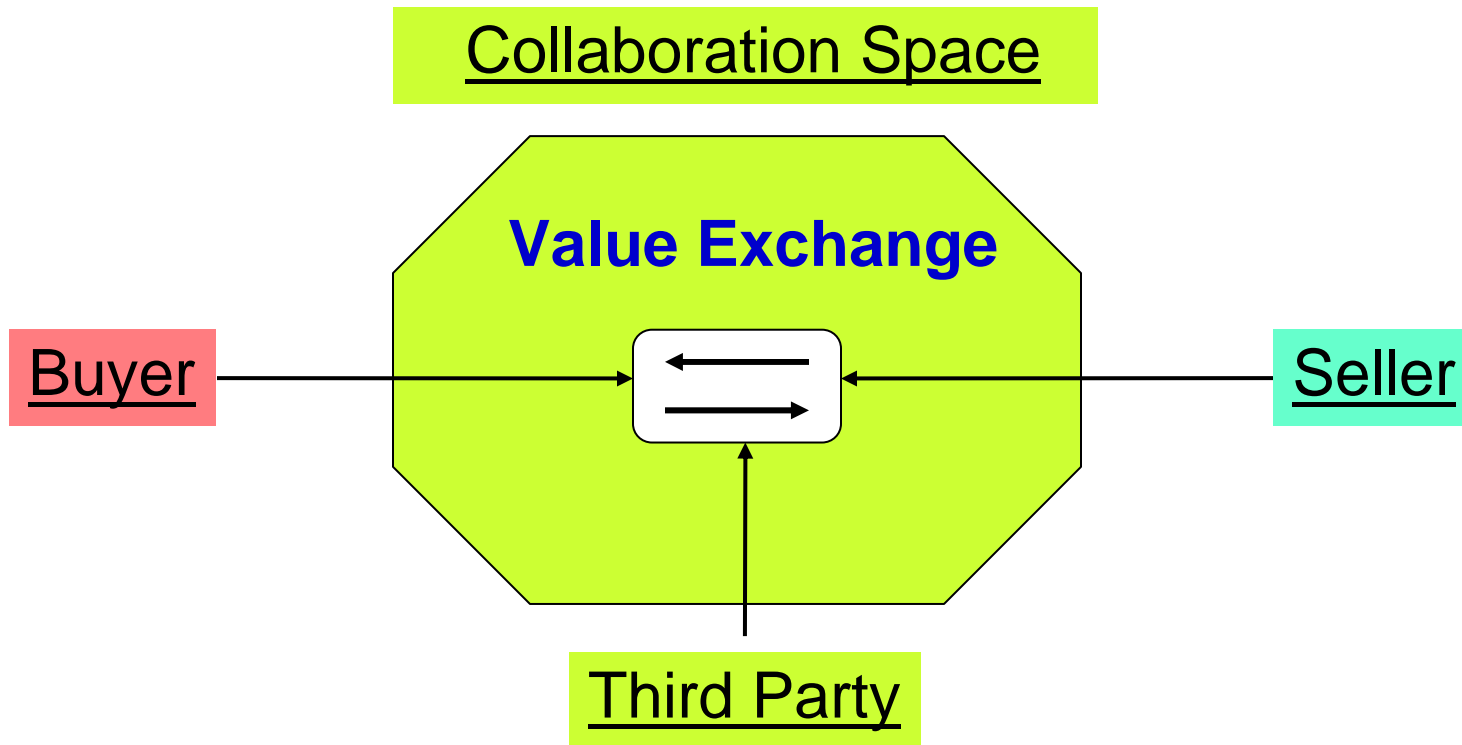


Figure 3 – Concept of a Business Collaboration

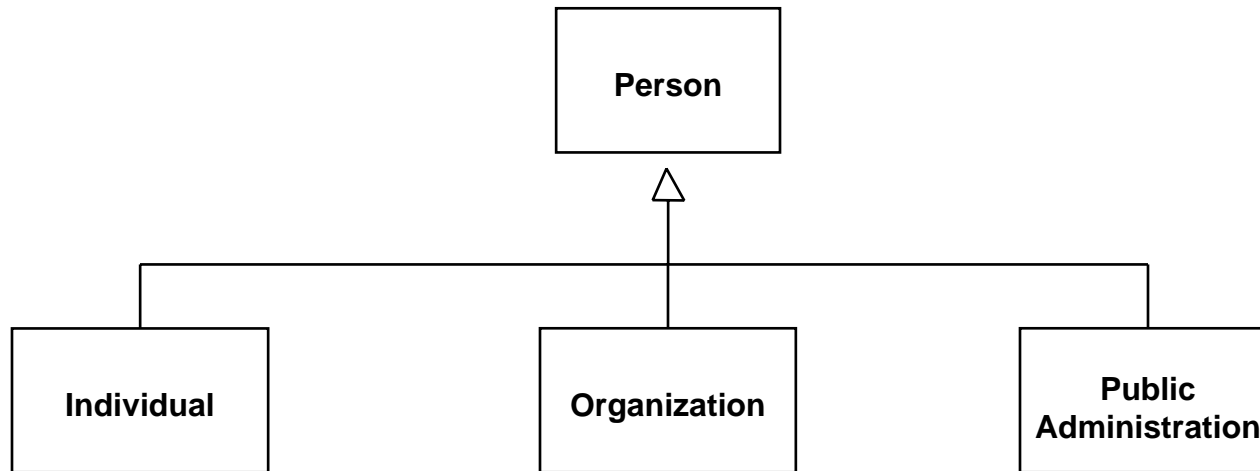


Figure 4 -- Subtypes of Person Based on Identity

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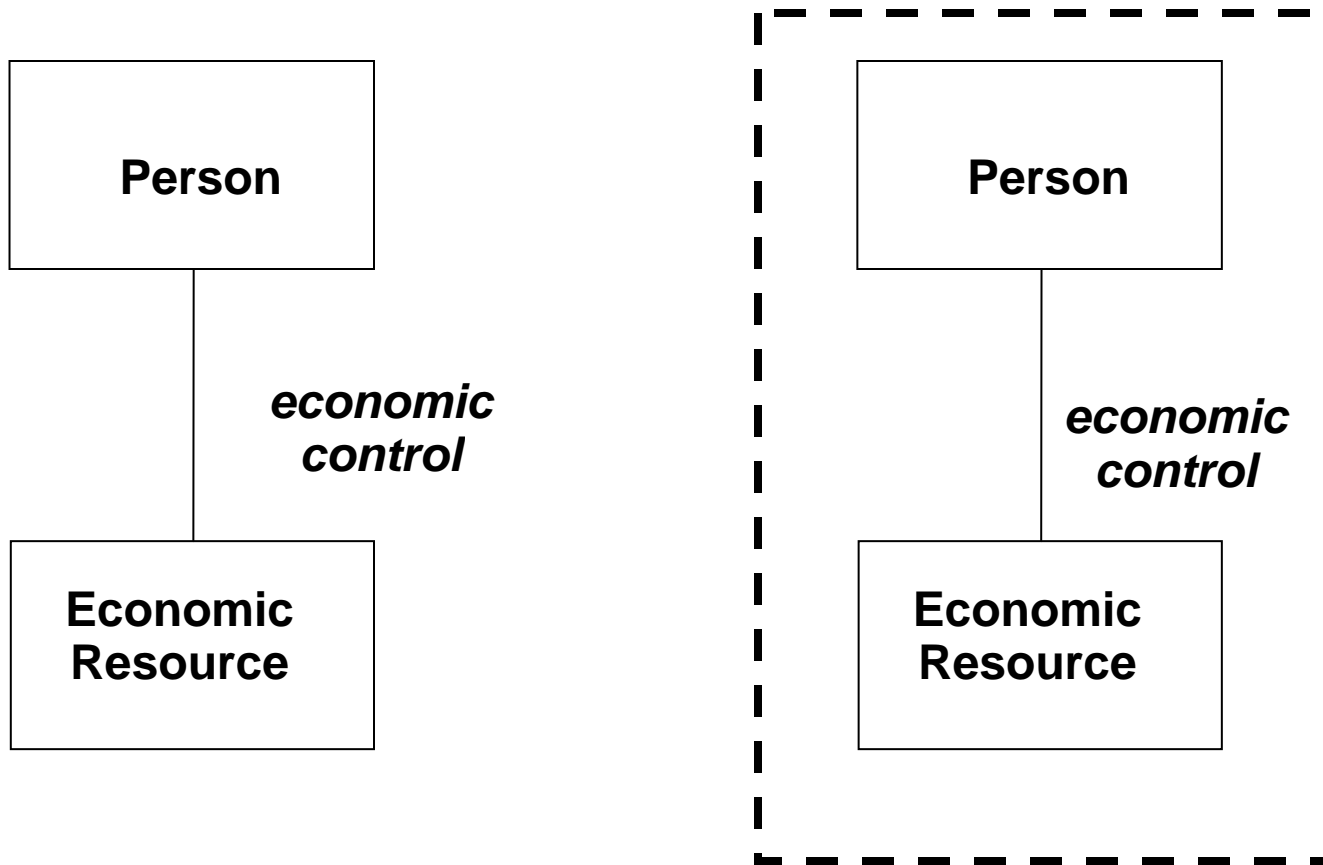


Figure 5 – Person and Economic Resource as the Basis for Exchange

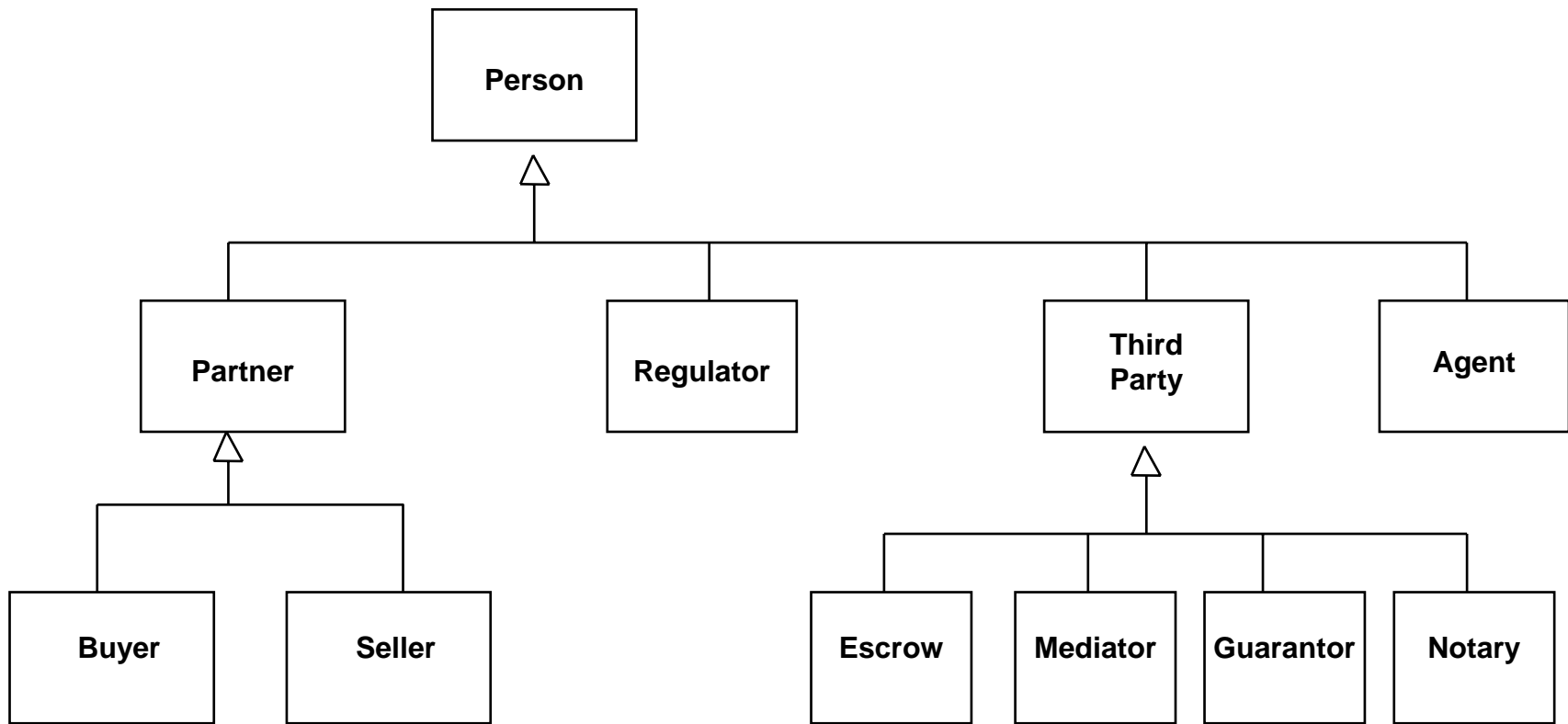


Figure 6 -- Subtypes of *Person* based on roles in a business transaction

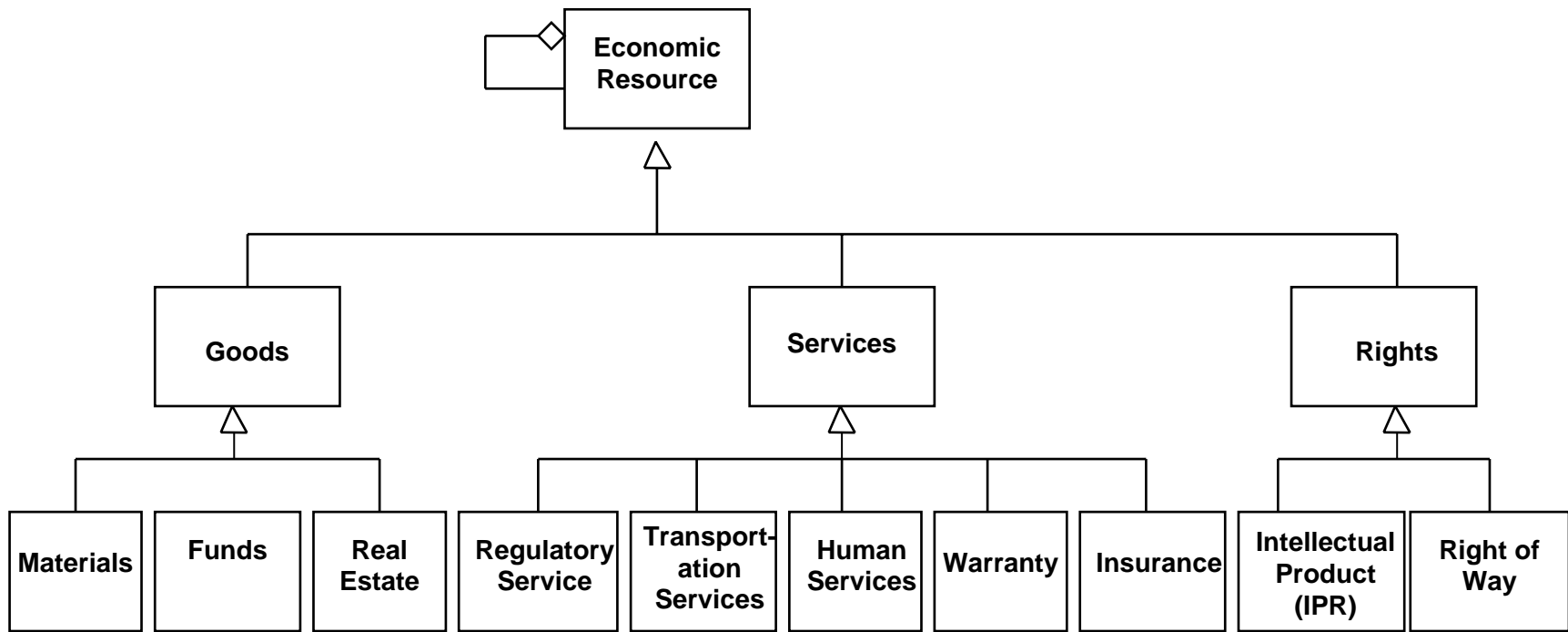


Figure 7 -- Subtypes (possible) for ECONOMIC RESOURCE

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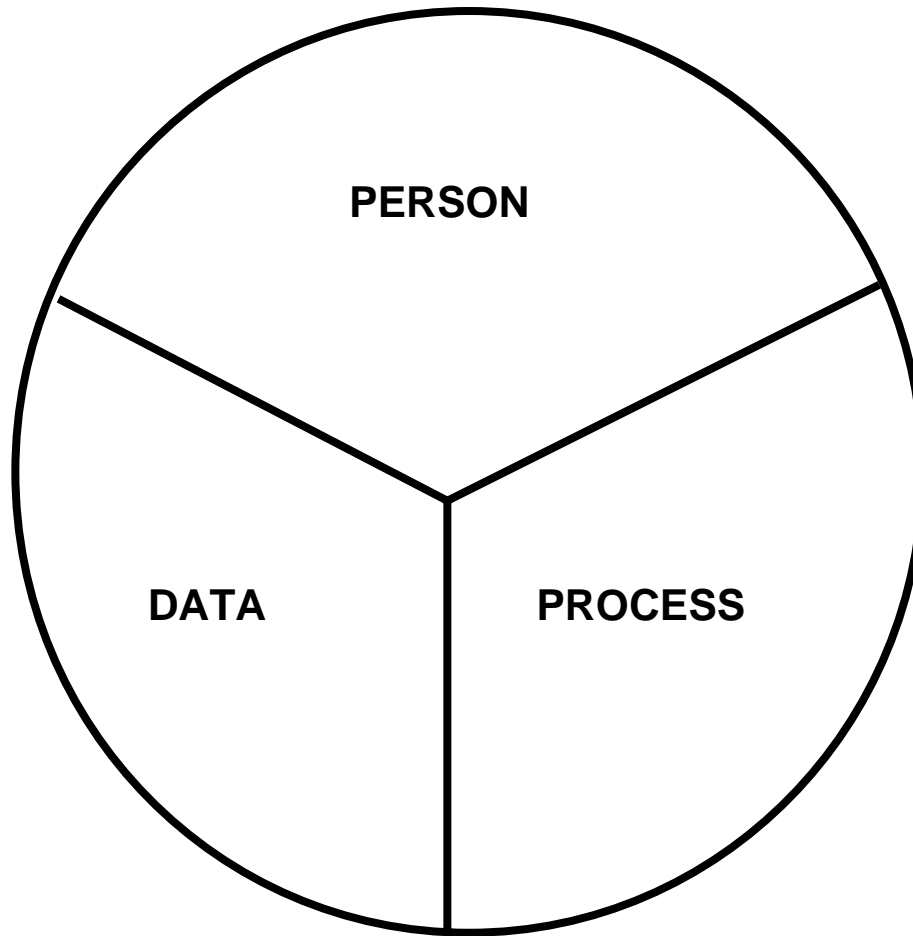


Figure 8 -- Fundamental Parts of a Business Transaction

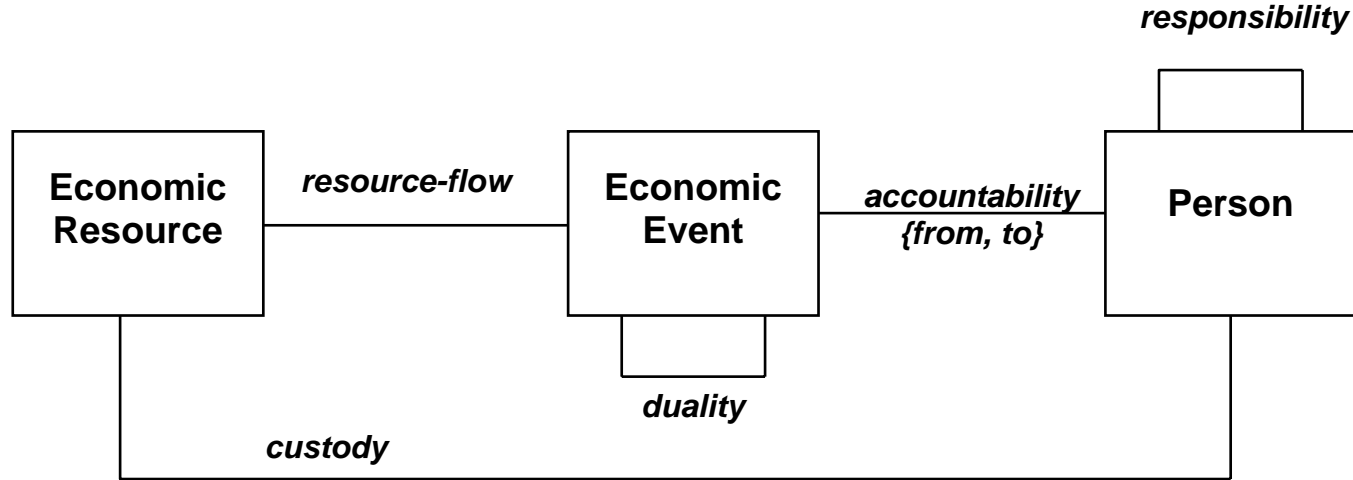


Figure 9 – Basic Exchange Primitives of the Open-edi Ontology

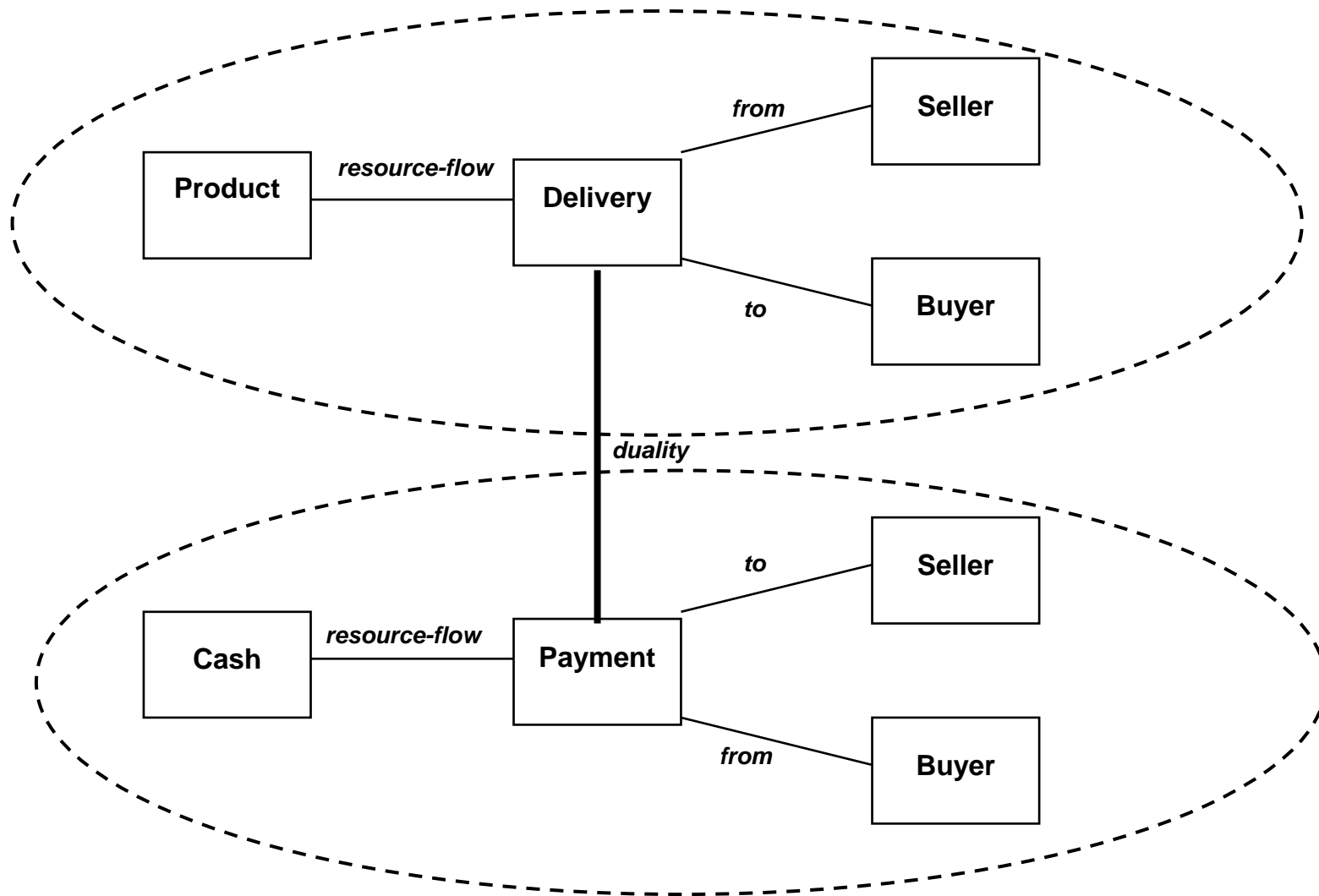


Figure 10 – Exchange of Value in Collaboration Space Involves Two Symmetrical Resource-Event-Person Clusters

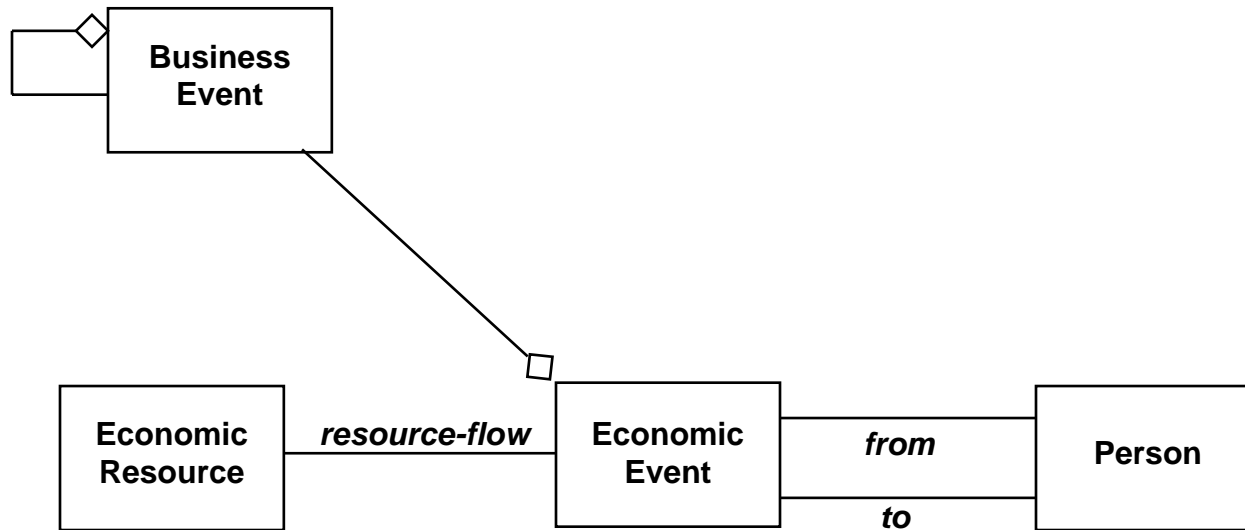


Figure 11 -- Addition of Business Event to Basic Business Transaction Pattern

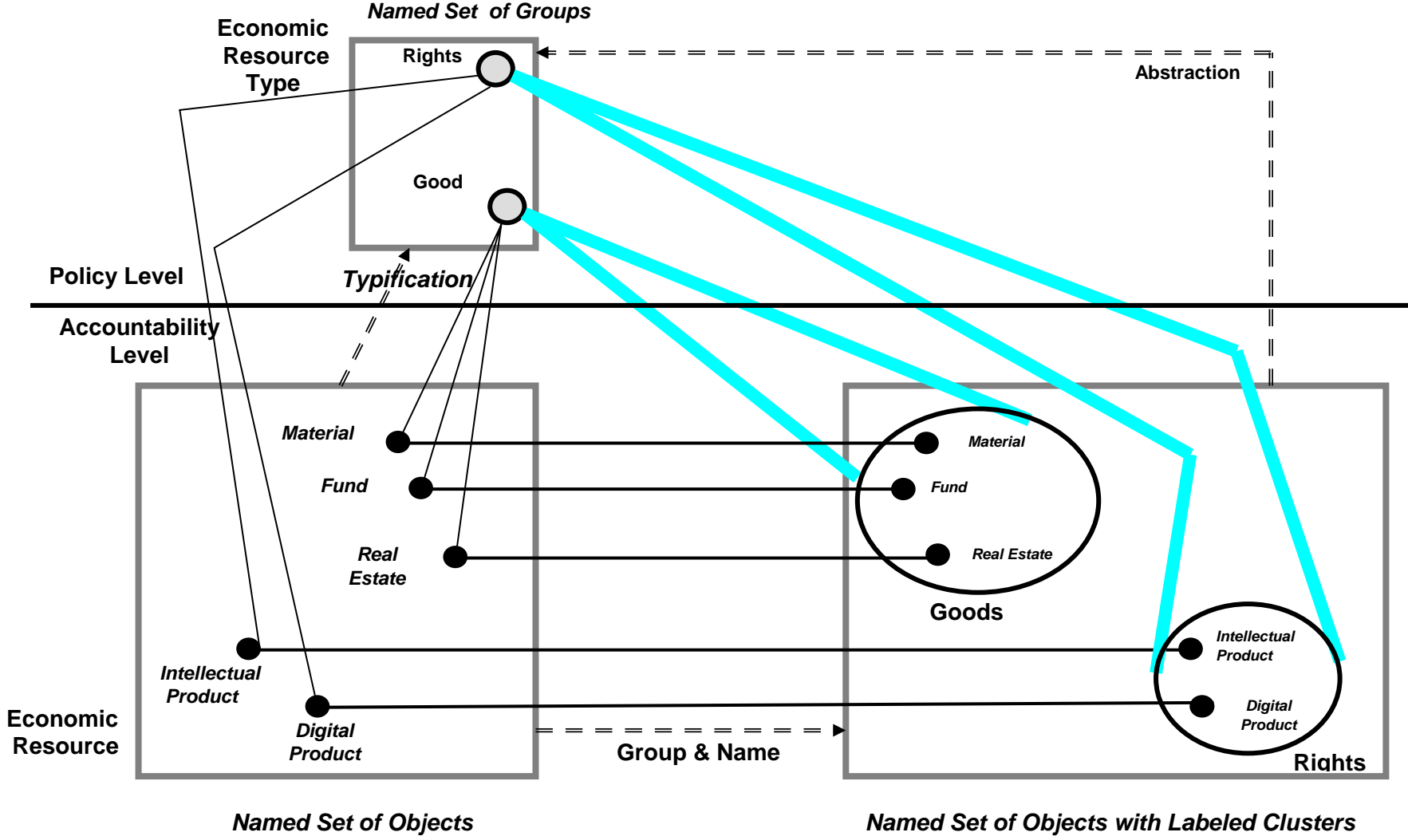


Figure 12 – Abstract Specification with Typification

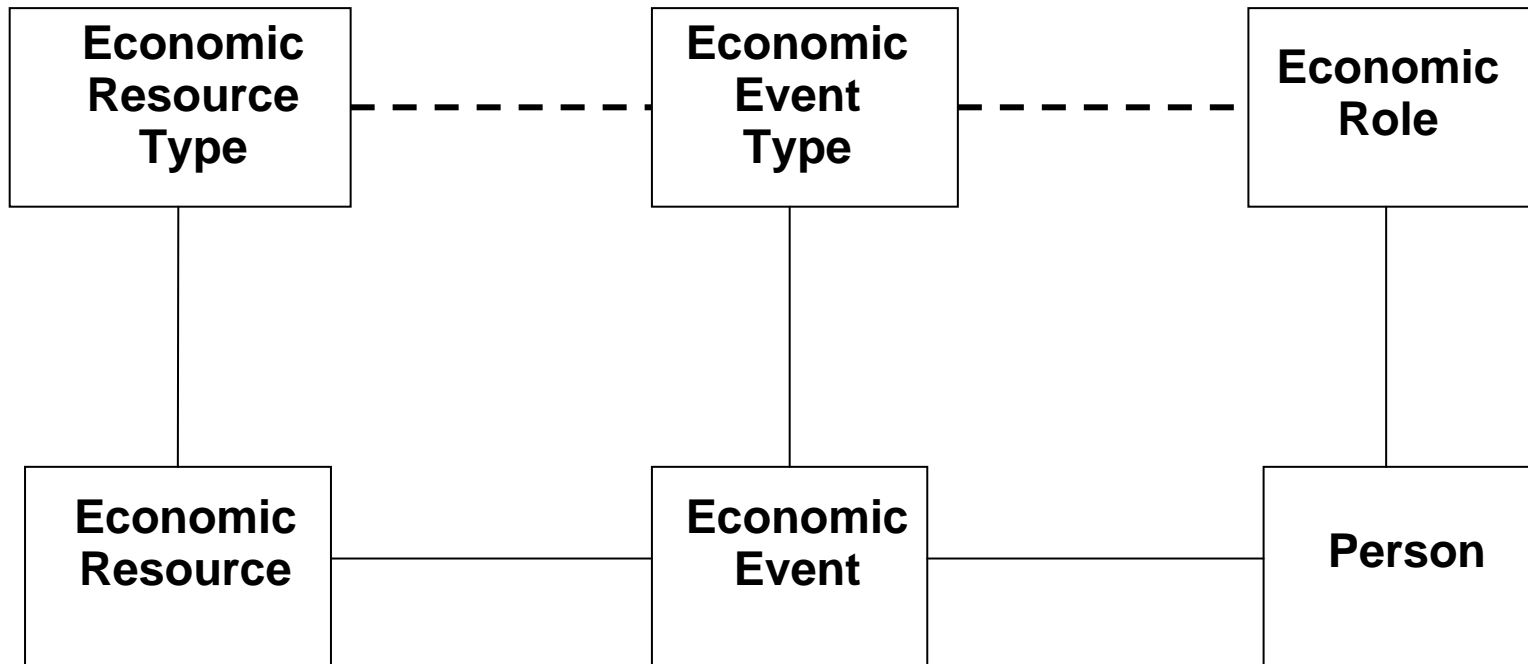


Figure 13 – Type Connections for Policy and Planning

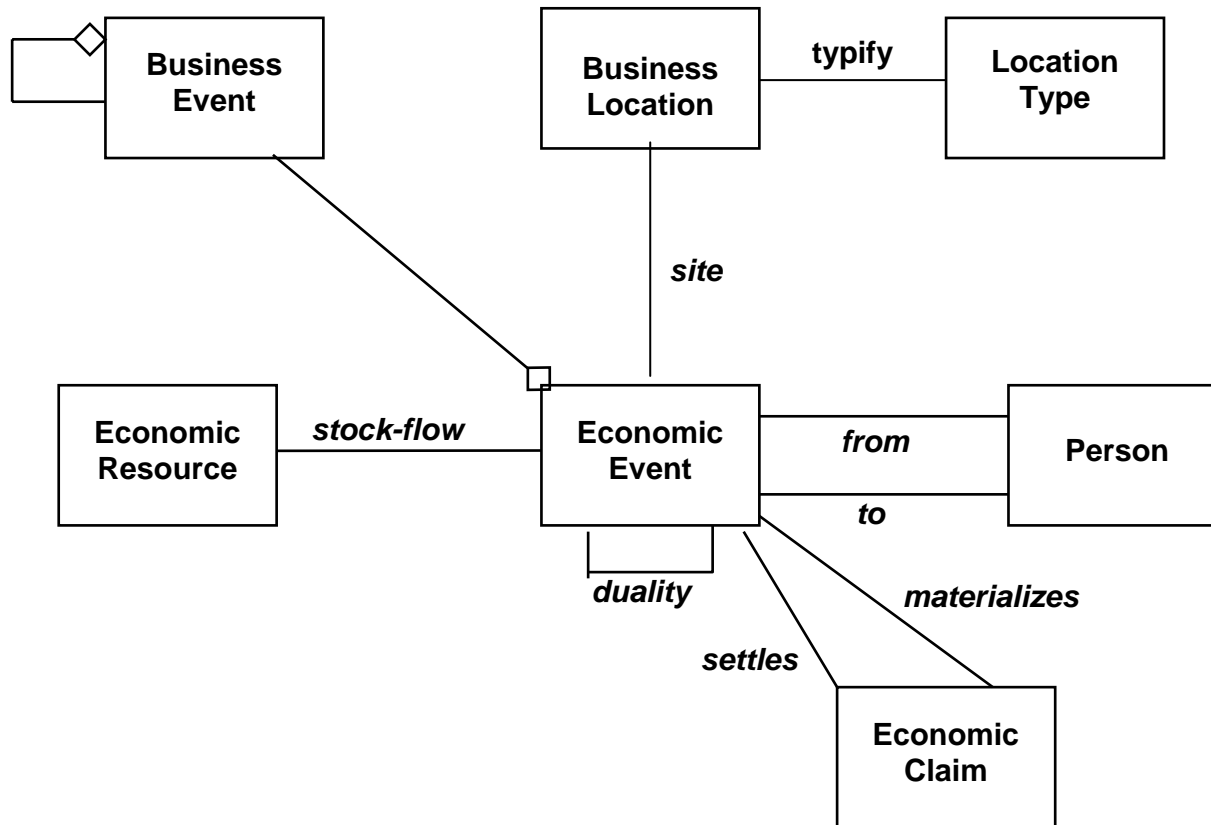


Figure 14 -- Addition of Location and Economic Claim

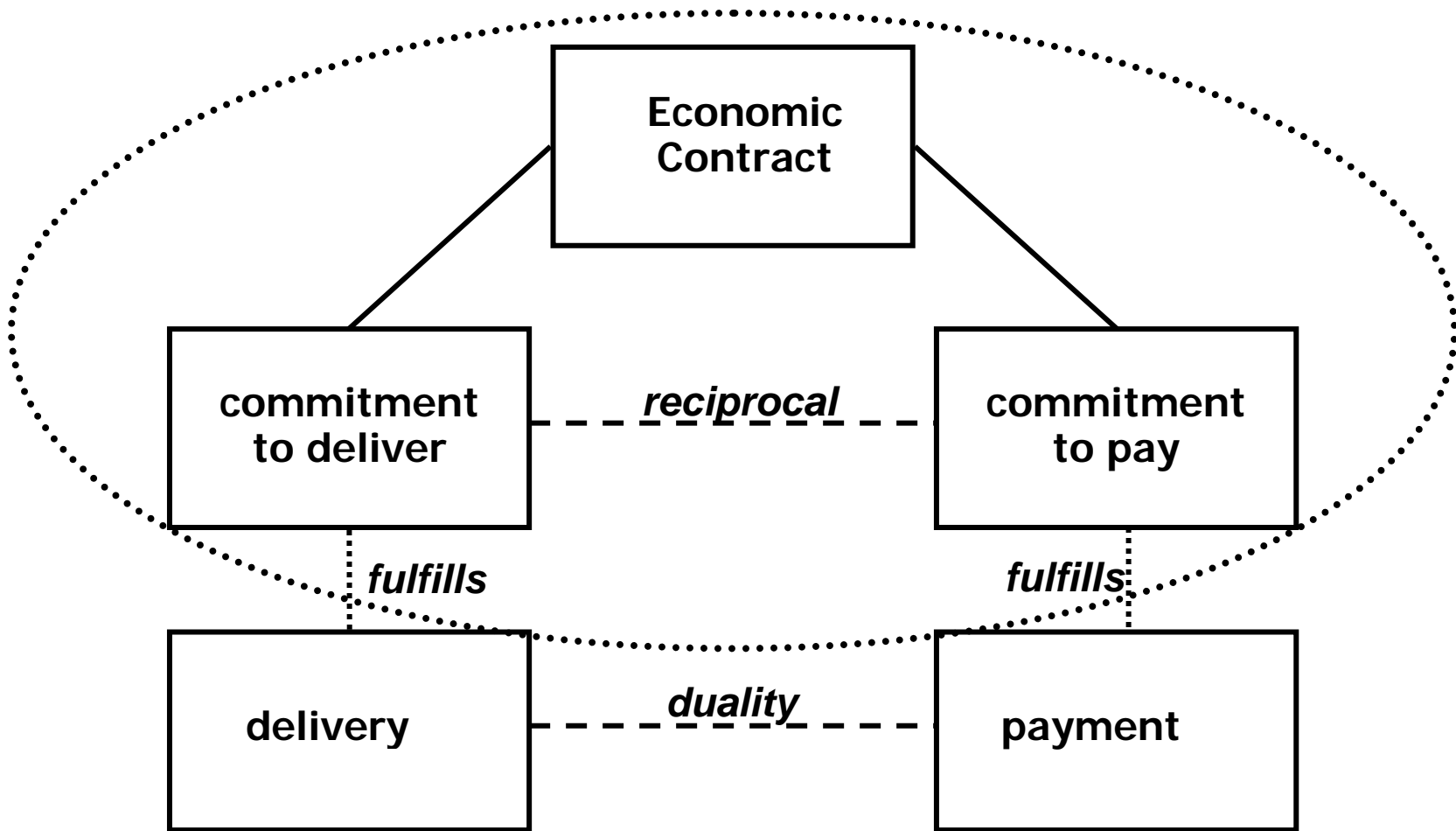


Figure 15 -- Contract as a Bundle of Commitments

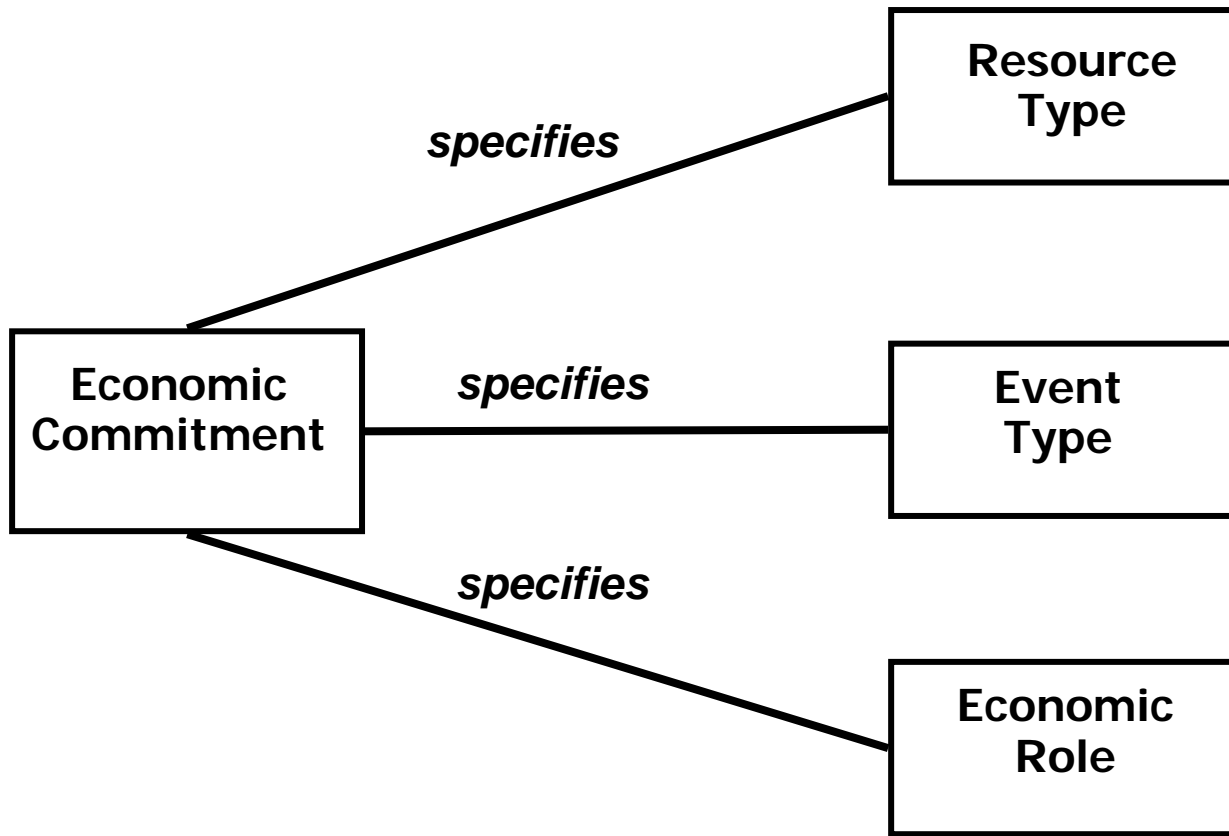


Figure 16 – Abstract Specification of Commitments

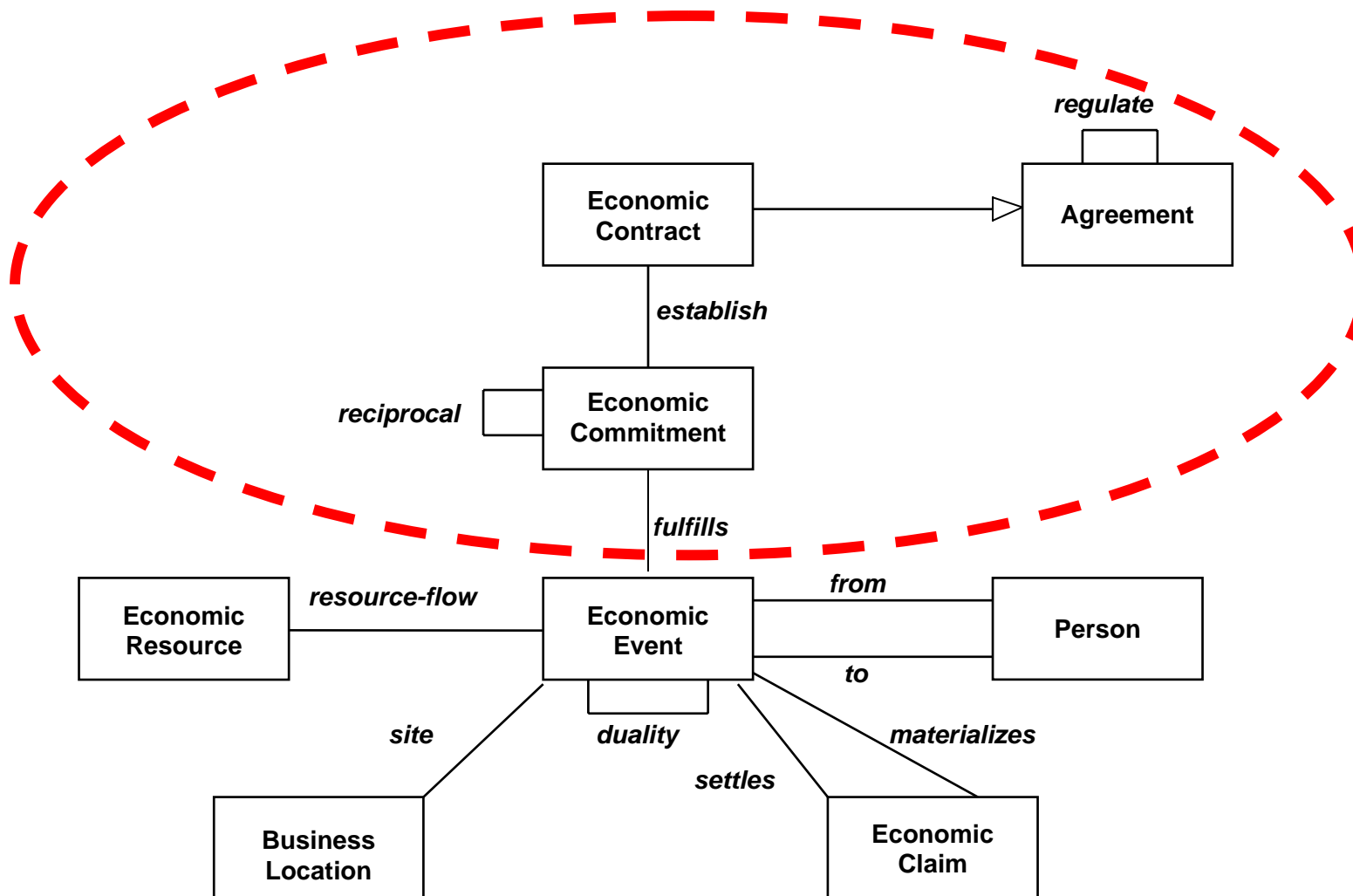


Figure 17 – Business Transaction Model with Bundled Commitments

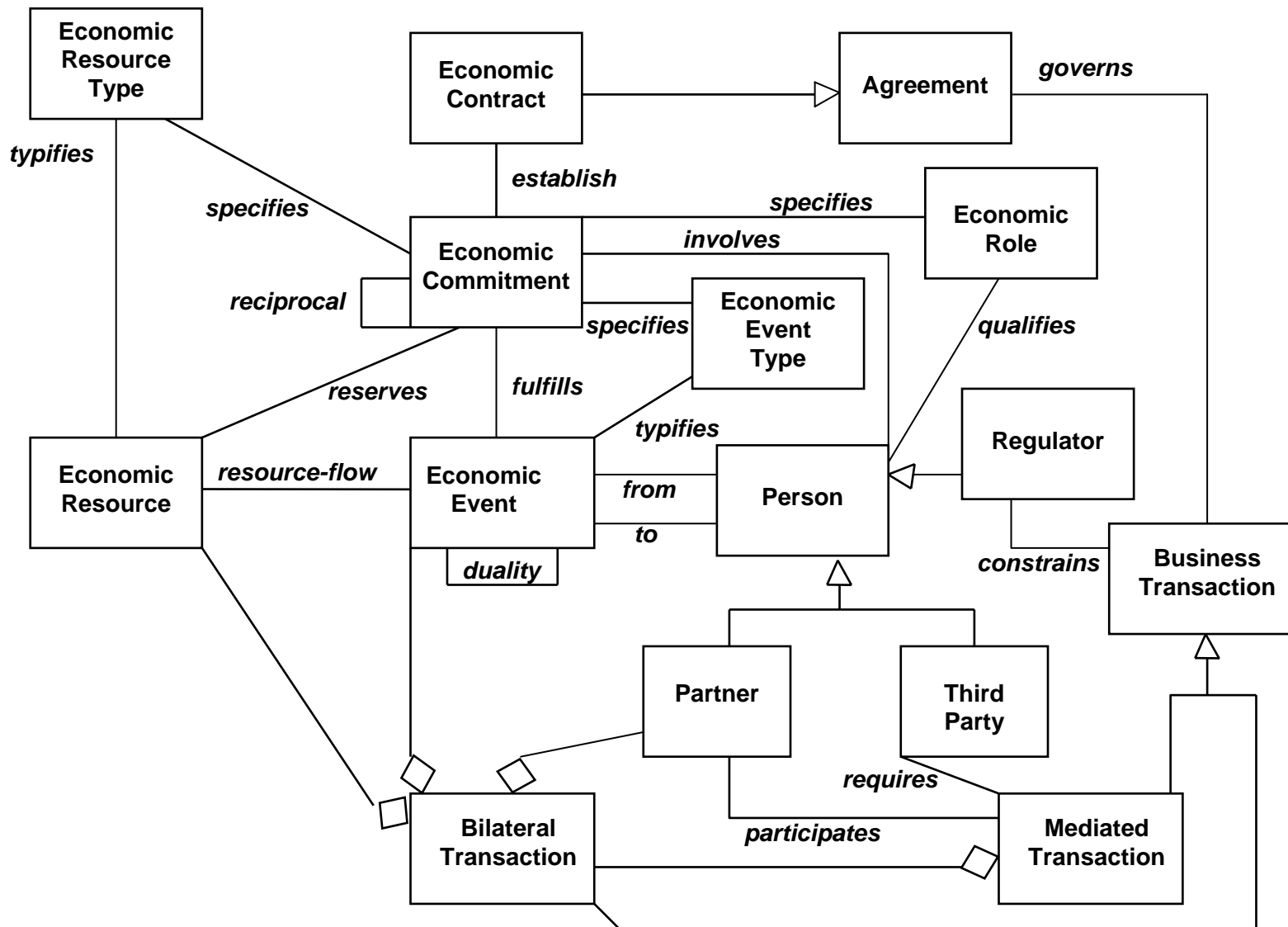


Figure 18 -- Collaboration with Commitment Structures

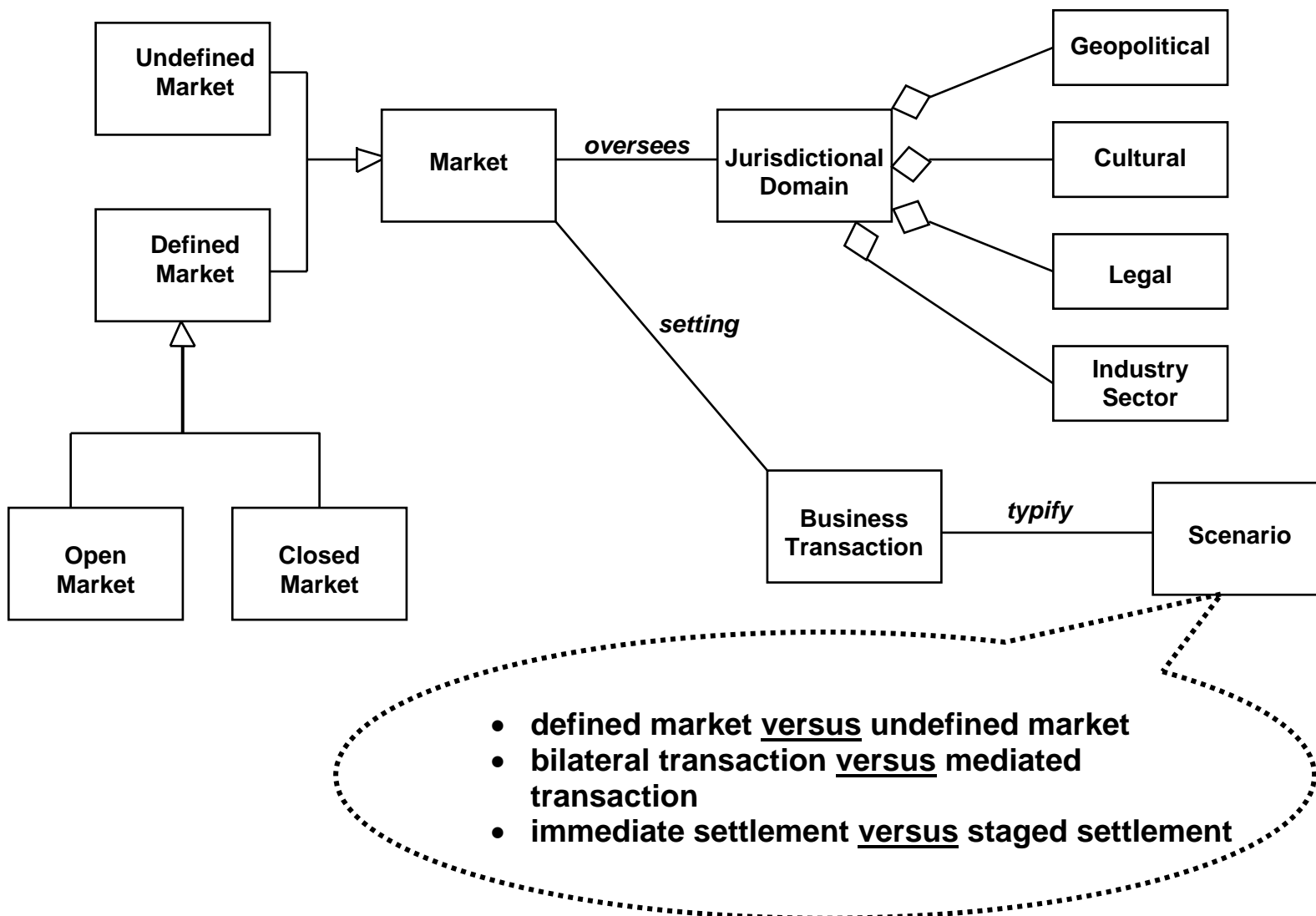


Figure 19 -- Addition of Markets and Scenarios for Business Transactions

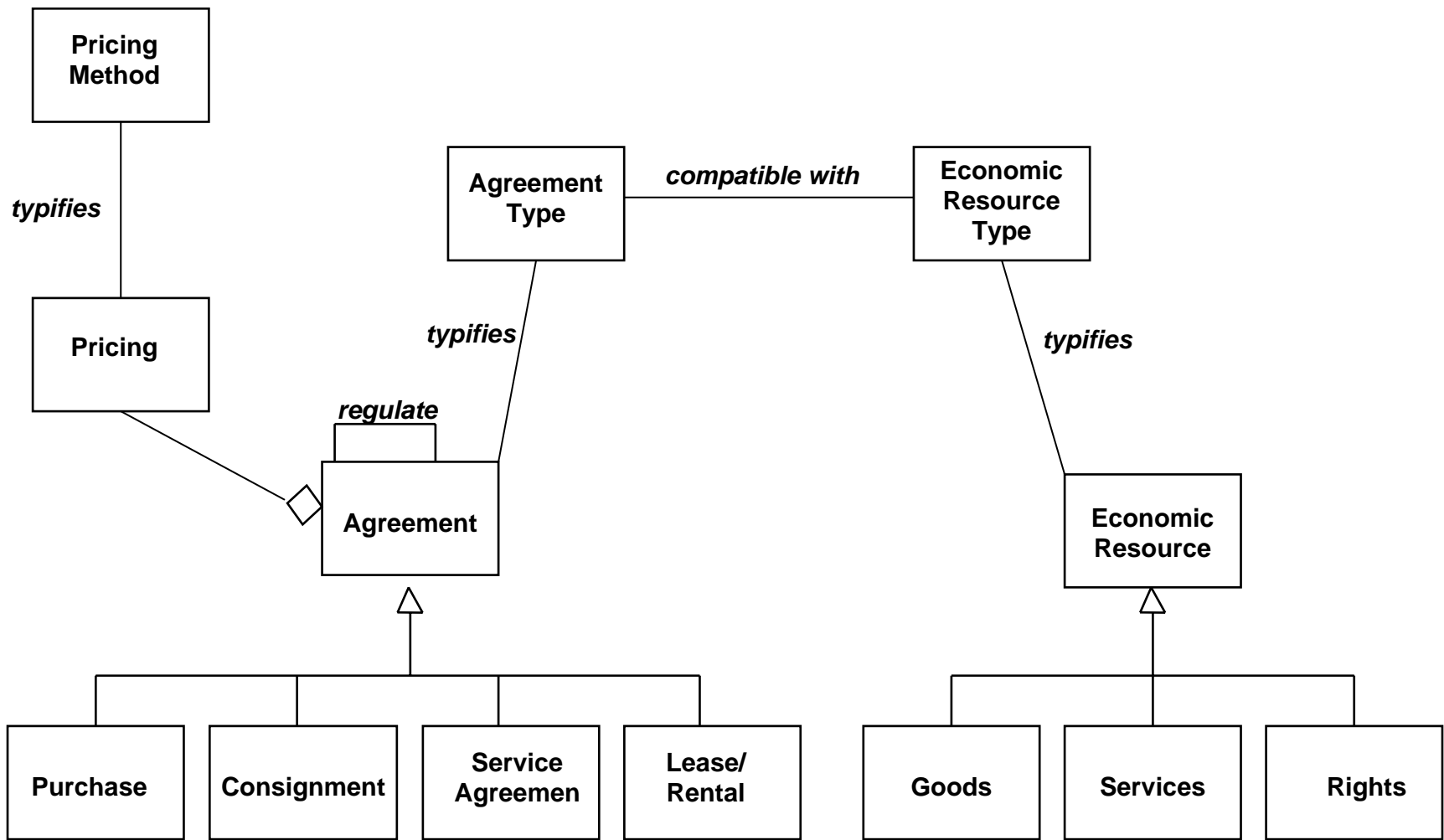


Figure 20 -- Agreement Types with Pricing Methods

- Planning: In the Planning Phase, both the buyer and seller are engaged in activities to decide what action to take for acquiring or selling a good, service, and/or right.
- Identification: The Identification Phase pertains to all those actions or events whereby data is interchanged among potential buyers and sellers in order to establish a one-to-one linkage.
- Negotiation: The Negotiation Phase pertains to all those actions and events involving the exchange of information following the Identification Phase where a potential buyer and seller have (1) identified the nature of good(s) and/or service(s) to be provided; and, (2) identified each other at a level of certainty. The process of negotiation is directed at achieving an explicit, mutually understood, and agreed upon goal of a business collaboration and associated terms and conditions. This may include such things as the detailed specification of the good, service, and/or right, quantity, pricing, after sales servicing, delivery requirements, financing, use of agents and/or third parties, etc.
- Actualization: The Actualization Phase pertains to all activities or events necessary for the execution of the results of the negotiation for an actual business transaction. Normally the seller produces or assembles the goods, starts providing the services, prepares and completes the delivery of good, service, and/or right, etc., to the buyer as agreed according to the terms and conditions agreed upon at the termination of the Negotiation Phase. Likewise, the buyer begins the transfer of acceptable equivalent value, usually in money, to the seller providing the good, service, and/or right.
- Post-Actualization: The Post-Actualization Phase includes all of the activities or events and associated exchanges of information that occur between the buyer and the seller after the agreed upon good, service, and/or right is deemed to have been delivered. These can be activities pertaining to warranty coverage, service after sales, post-sales financing such as monthly payments or other financial arrangements, consumer complaint handling and redress or some general post-actualization relationships between buyer and seller.

SOURCE: ISO FDIS 15944-1 – *Operational Aspects of Open-edi for implementation*

Figure 21 -- ISO Open-edi Phases of a Business Transaction

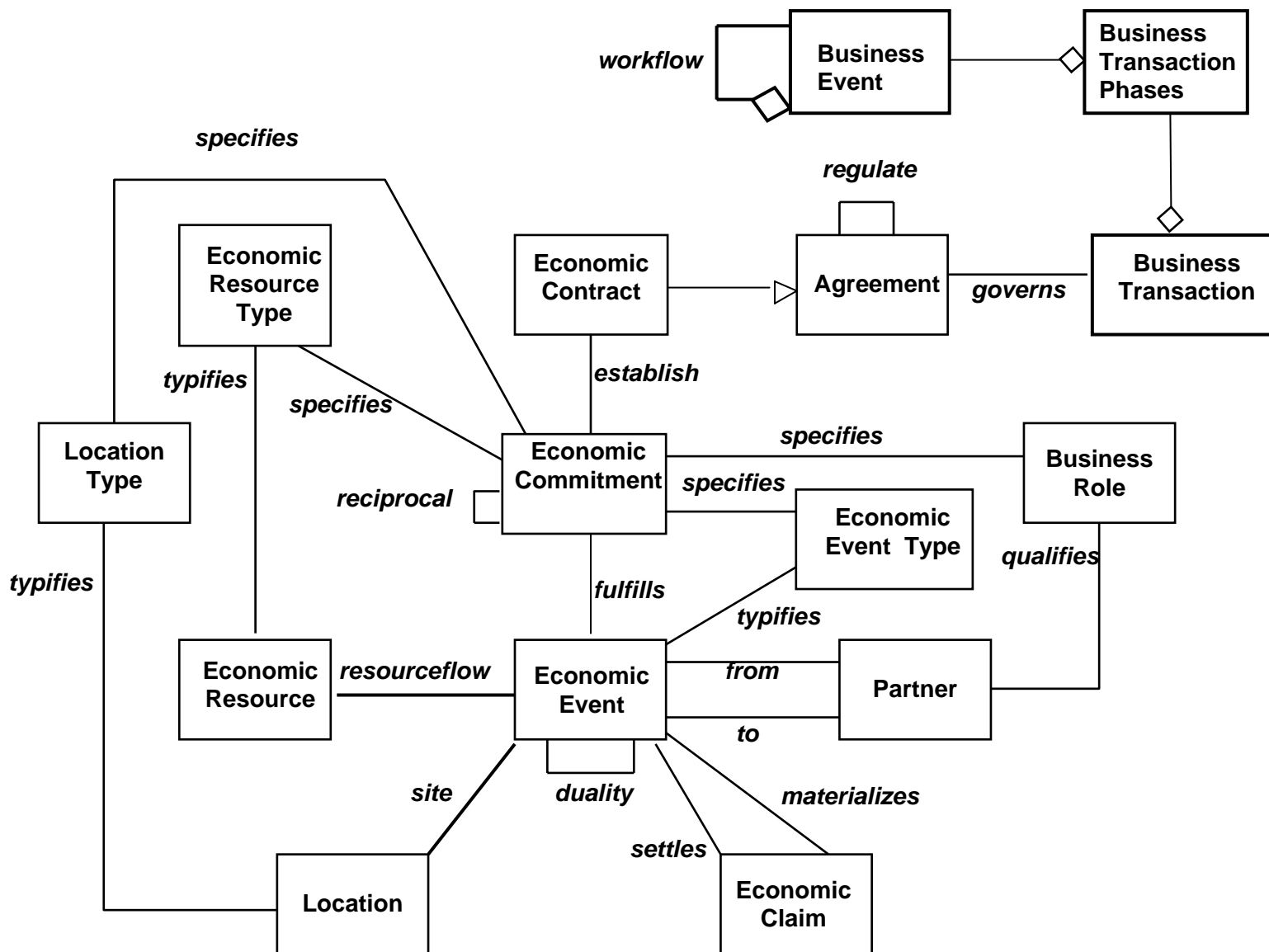


Figure 22 -- Open-edi Ontology with Business Events

Business Transaction

Ontological Components

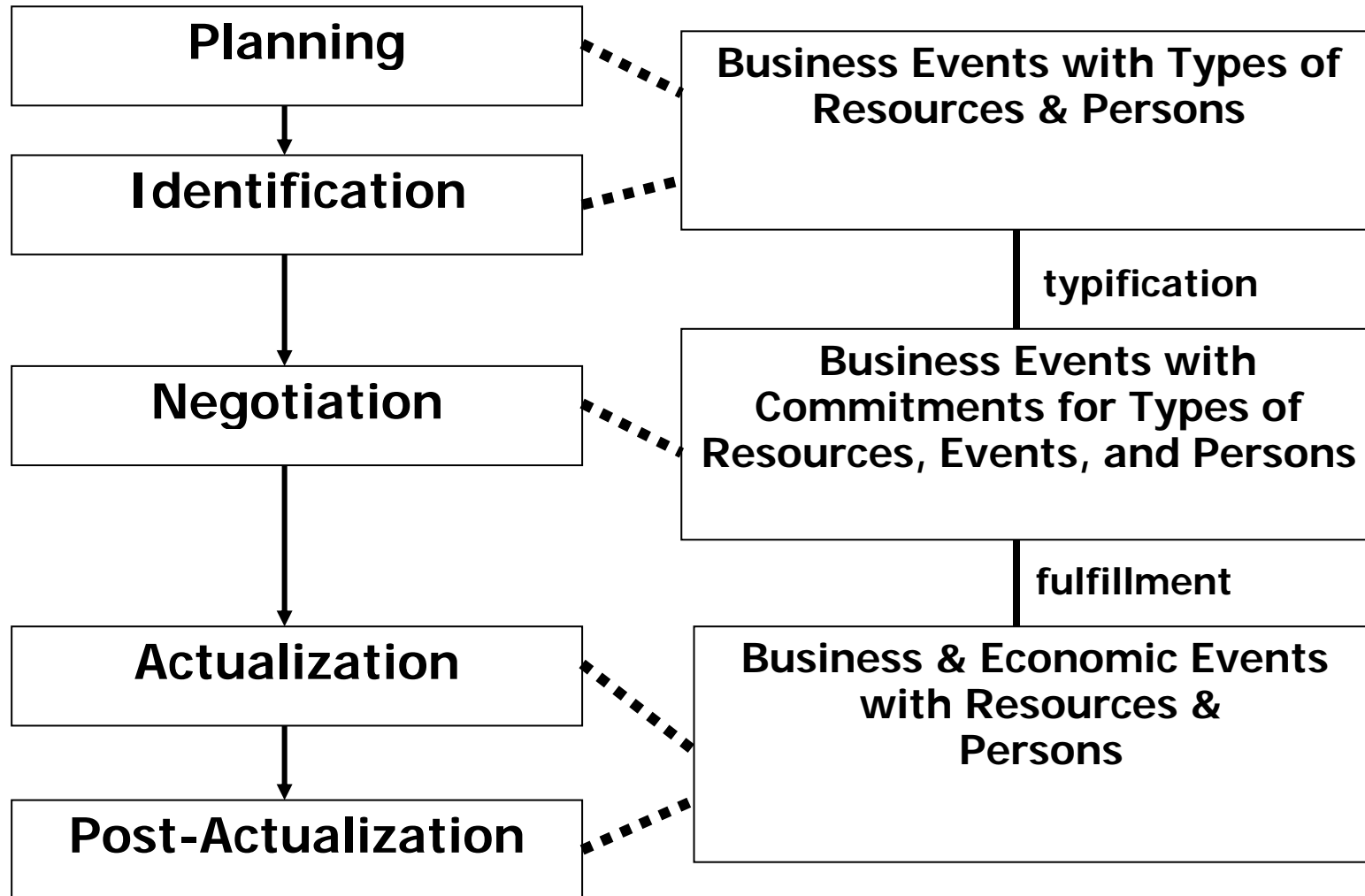


Figure 23 -- ISO Open-edi Phases with Components

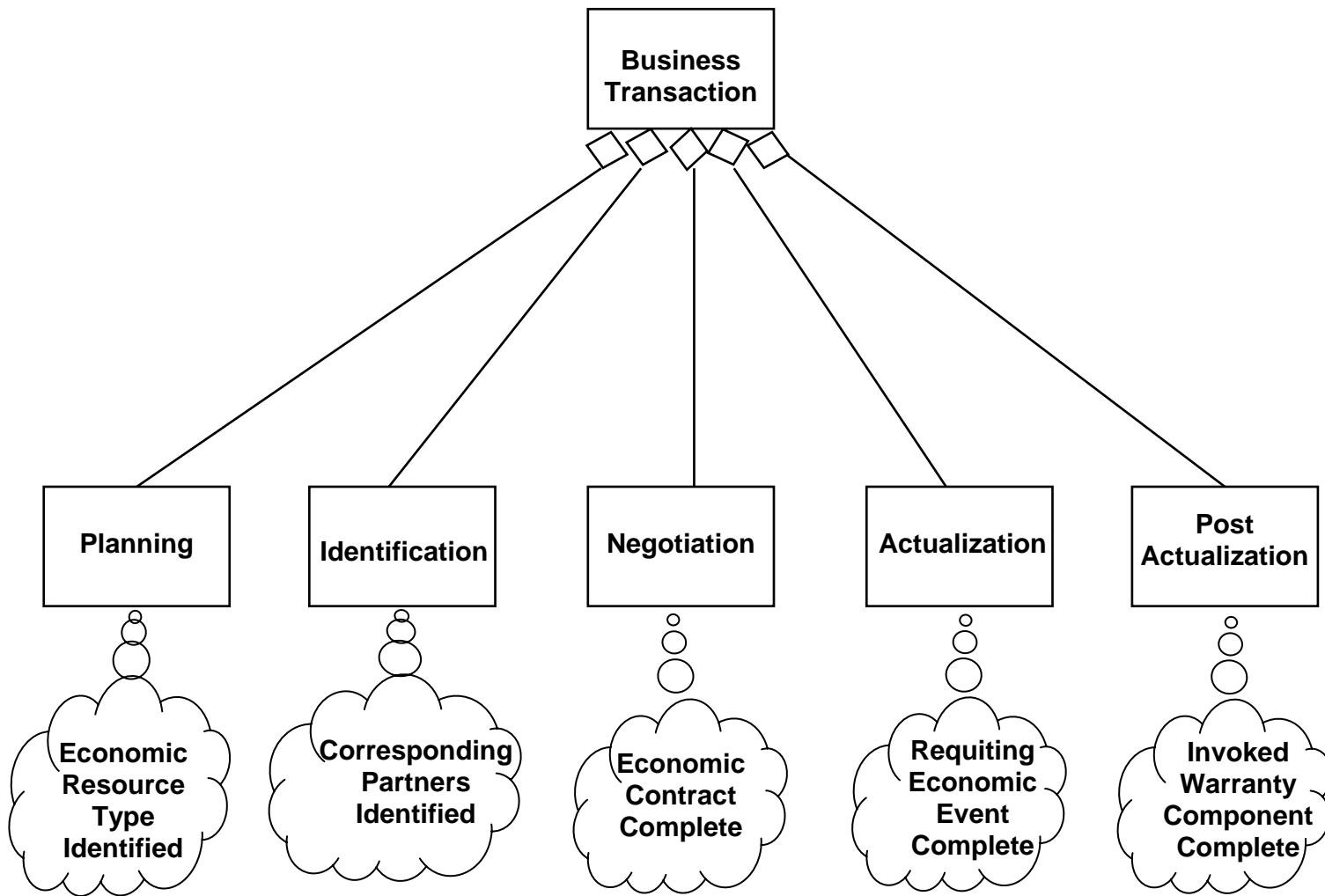


Figure 24 -- Phases of a Business Transaction and Object States for Completion

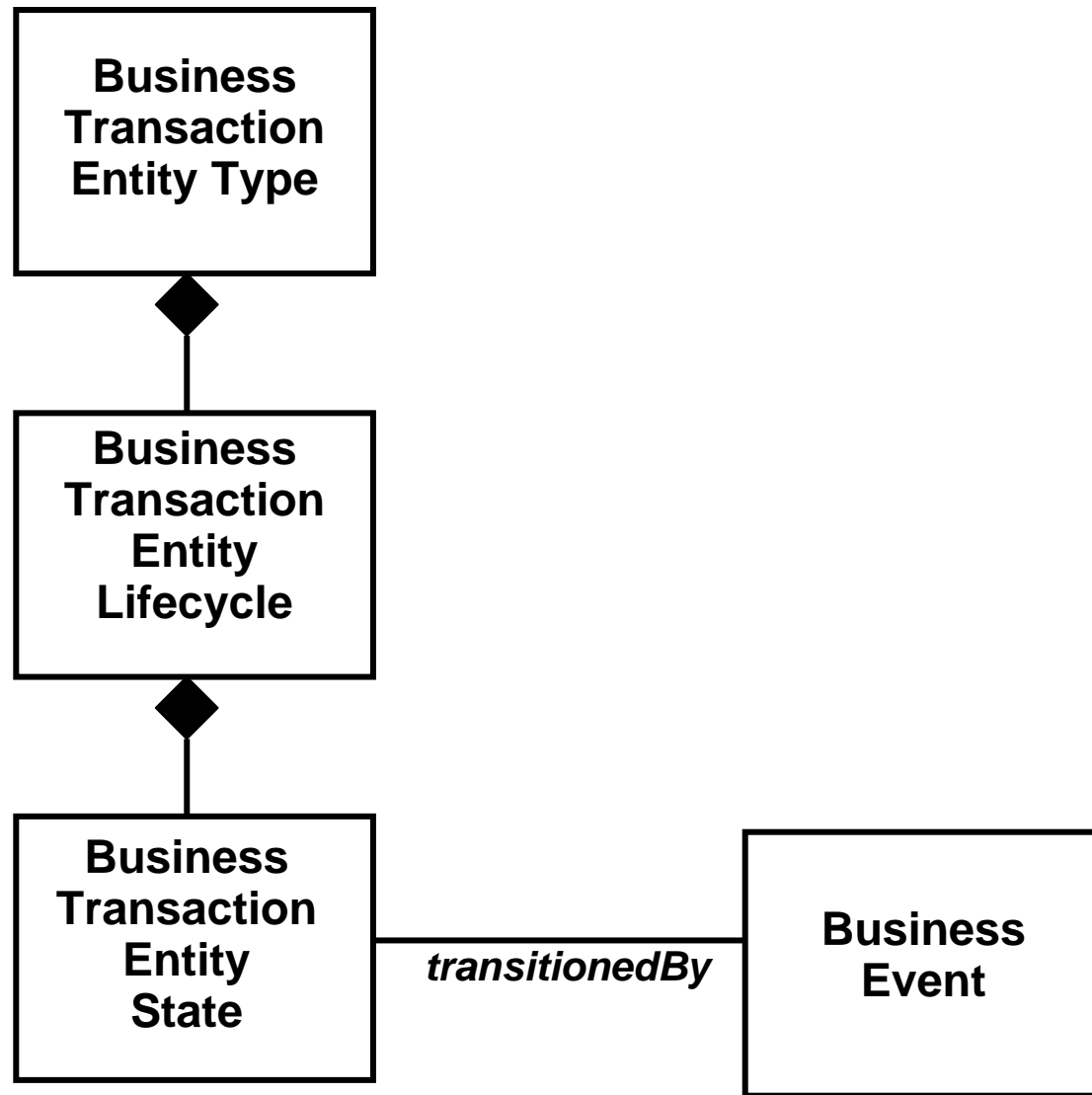
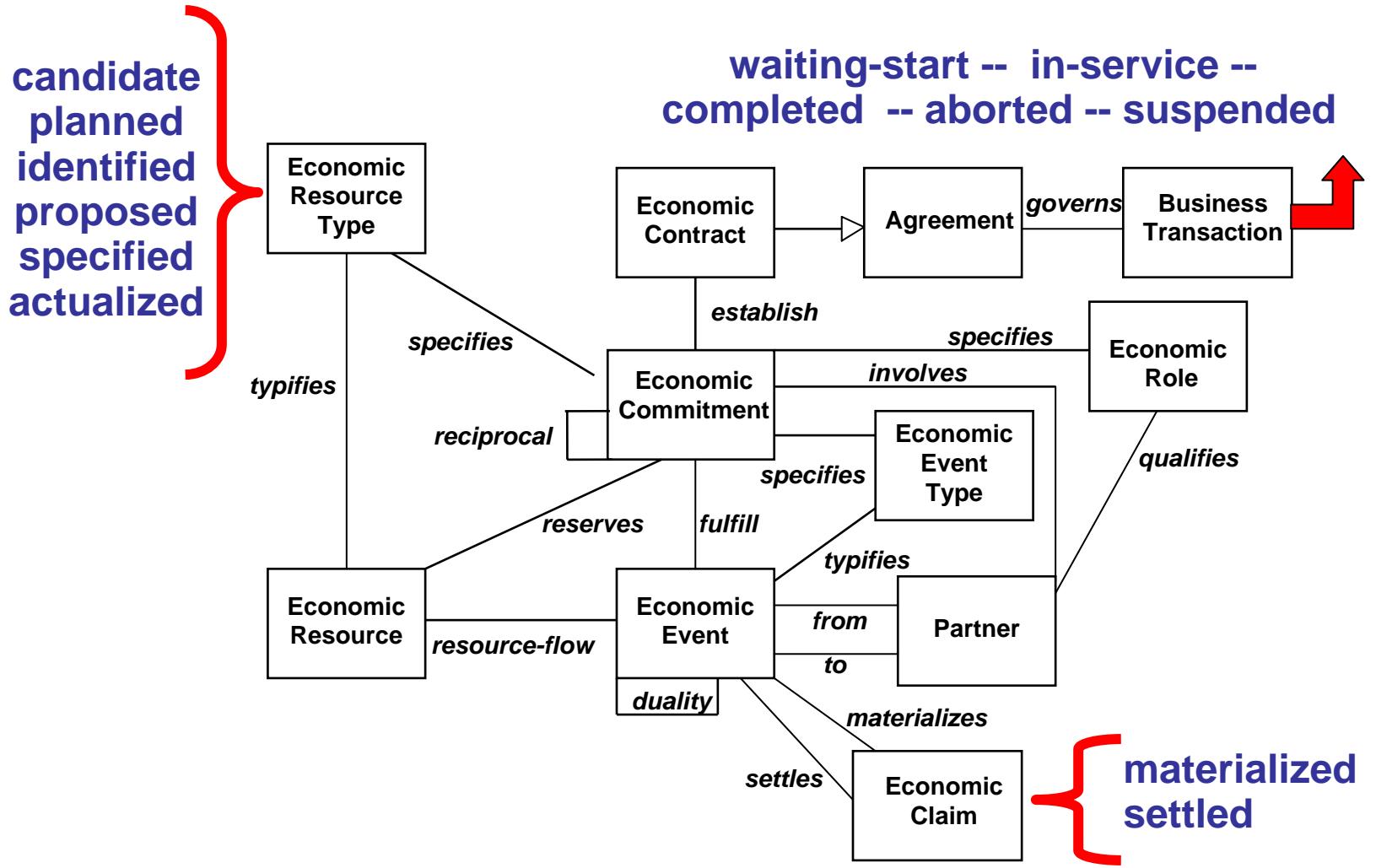


Figure 25 – Business Objects, Lifecycles, States, and Events

<u>Sample Business Transaction Entity</u>	<u>Example States (Lifecycles) for Business Transaction Entity</u>
Business Transaction	<ul style="list-style-type: none"> • Waiting-Start • In-Service • Completed • Aborted • Suspended
Economic Claim	<ul style="list-style-type: none"> • Materialized • Settled
Economic Resource Type	<ul style="list-style-type: none"> • Candidate • Planned • Identified • Proposed • Specified • Actualized
Business Transaction Phase	<ul style="list-style-type: none"> • Pending • In-Service • Complete

Figure 26 – Sample States for Business Transaction Entities



negotiation-pending → negotiation-in-service → negotiation-complete

Figure 27 -- Sample Business Objects with State Life Cycles

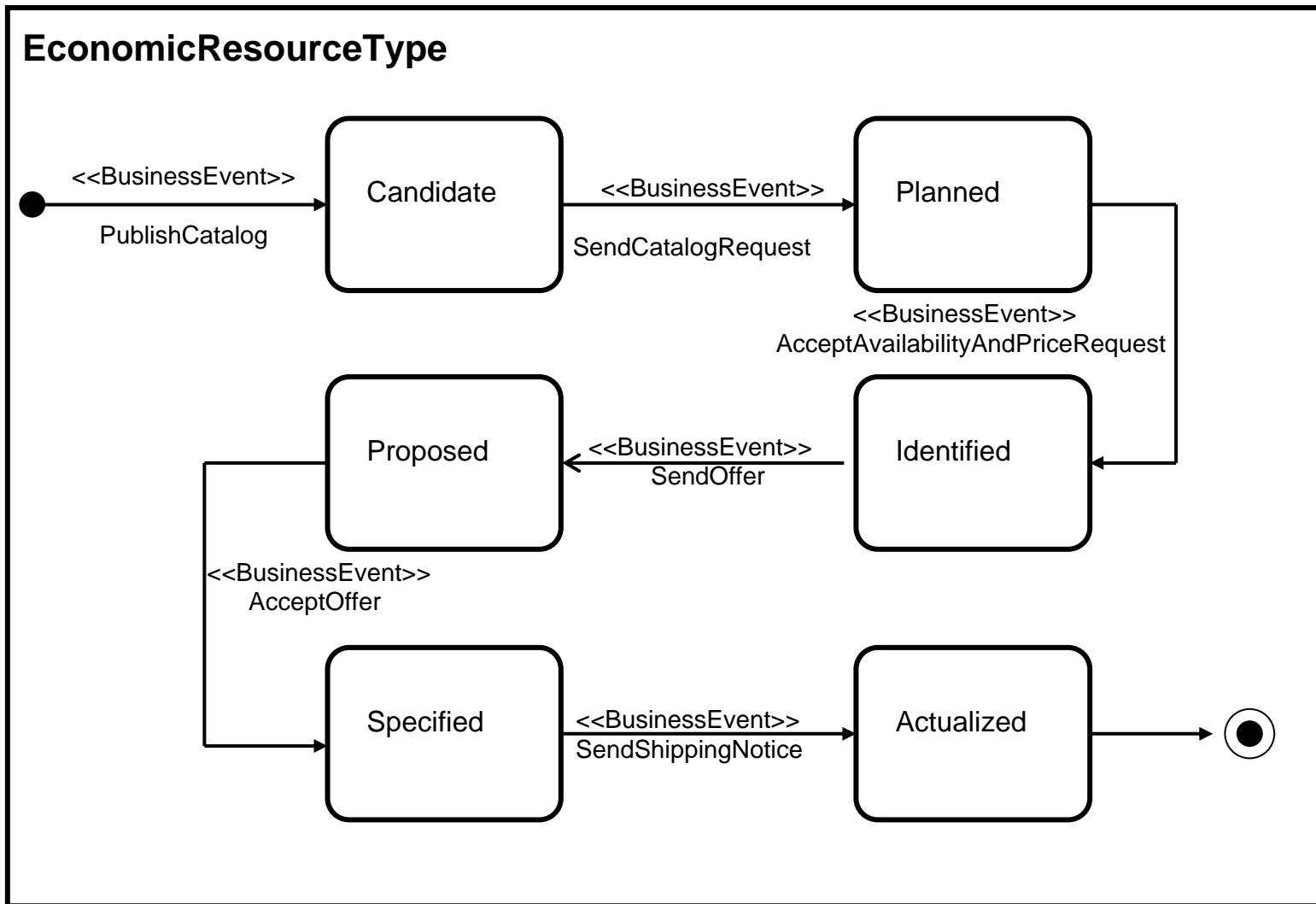
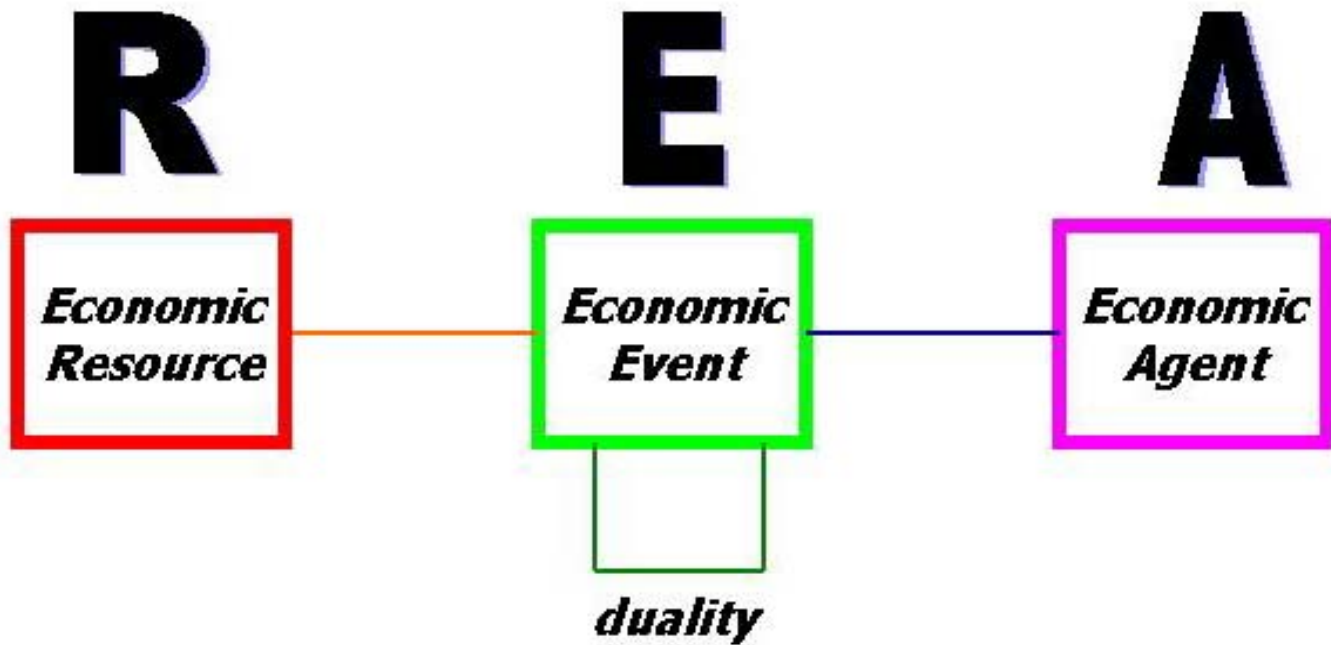


Figure 29 – State Machine Diagram for Economic Resource Type



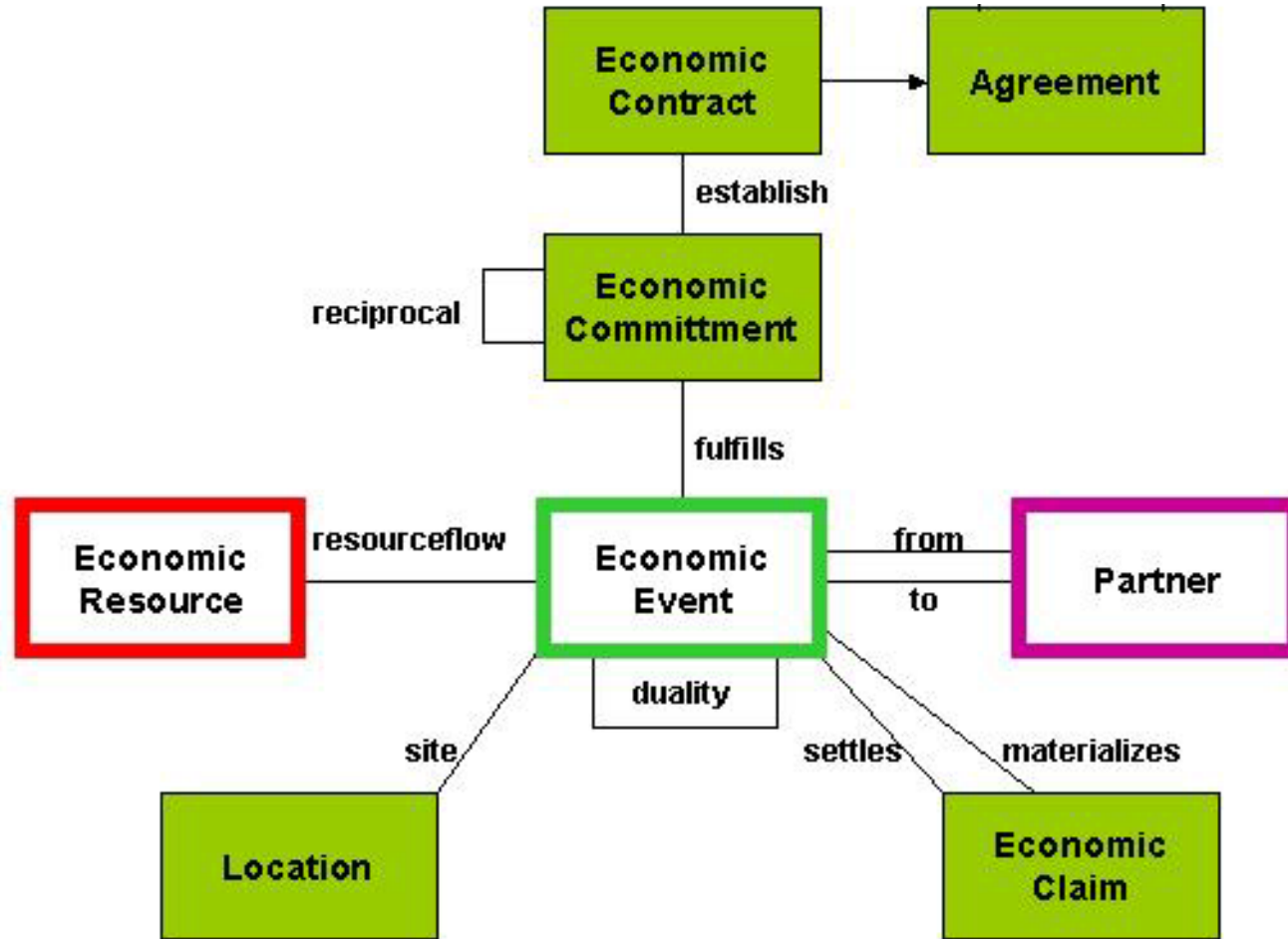
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Appendix Figure A-1-- Basic REA Ontology

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Appendix Figure A-2 -- REA Ontology with Commitments

Functional criteria	REA explanation
Does it express the consensus knowledge of a community of people?	The original paper and all extensions since have been published in high quality refereed journals (<i>The Accounting Review</i> , <i>IEEE Intelligent Systems</i> , etc.) where its components are open to constant review and criticism. In 1996, the original paper was given the first <i>Seminal Contribution to the Accounting Information Systems Literature Award</i> by the American Accounting Association. The Work was most recently awarded the <i>2003 Innovations in Accounting Education Award</i> by the AAA.
Do people use it as a reference of precisely defined terms?	The three leading textbooks on accounting systems analysis and design all use REA extensively to define system primitives and to explain modeling of accounting phenomena.
Is the language used expressive enough for people to say what they want to say?	The REA primitives may be used to model any of the economic dealings of an enterprise. The actual chain of entrepreneurial logic might itself be hard to explicate in a minority of cases (why for instance do firms support public charities or why is training important for employees ?), but once those links are made at some level of granularity, REA primitives are able to document them.
Is it stable?	The original paper was published in the top accounting journal in the world (<i>The Accounting Review</i>) in 1982. No substantive criticisms of its features have been published in the intervening 20 years.
Can it be used to solve a variety of different sorts of problems or as a starting point to construct multiple sorts of applications?	REA can be used to model and design the accounting components of software systems. It has also been used to model external business processes or business collaborations for ebXML and TMWG of UN/CEFACT. It has also been used to model inter-firm phenomena such as supply chains and to analyze the efficacy of a variety of enterprise software systems. Moreover, this documentation can be expressed at multiple levels of granularity, ranging from high level value chains and supply chains all the way down to the level of workflow tasks (see Figure 2). The original model covered both inter- and intra-enterprise transactions, but its use can be specialized for either case.

Appendix Figure A-4 – Ontology Criteria and REA

<u>OVERALL CONCEPT</u>	<u>ISO OPEN-EDI</u>	<u>REA ONTOLOGY</u>	<u>UN/CEFACT TMG, ebXML & eBTWG</u>
Emphasis on “economic value” as foundation for business process and business collaboration definitions	<i>A business transaction</i> pertains to the exchange of something of value	An exchange involves required <i>economic events</i> wherein one <i>economic resource</i> – which is something of value under the control of an enterprise – is exchanged for another <i>economic resource</i>	A business collaboration is an activity where “one thing of measurable value is created, either as a service performed or as a product created
Designated “actors” or agents who participate in the economic activities within or between business enterprises or who are responsible for the participation of others	<i>Person</i> is a legal or human entity having the ability to make commitments and to fulfill resulting obligations, and to be held accountable for those obligations	<i>Economic Agents</i> include persons and agencies who participate in the economic events of the enterprise or who are responsible for subordinates’ participation	<i>Partner</i> is an actor in a business collaboration
The ability to make and impart information about <i>commitments</i> as a critical component of e-commerce	A key property of a business transaction is that it involves <i>commitment exchange</i> among persons	A <i>commitment</i> is an agreement to execute an economic event in a well-defined future that will result in either an increase of resources or a decrease of resources	An economic commitment is an obligation to perform an economic event (that is, transfer ownership of a specified quantity of a specified resource type) at some future point in time
Pre-established patterns for different classes of e-commerce collaboration at the business or economic level	An <i>Open-edi Scenario</i> is a formal specification of a class of business transactions having the same business goal	A Scenario is a configuration of event types, resource types, commitment types, and agent types aggregated together to illustrate prototypical behavior	Run-time <i>Declarative Collaboration Patterns</i> are work items being developed based on the BRV components of the UMM meta-model

Appendix Figure A-5 – Correspondence of ISO, REA, and UN/CEFACT