

THE LEGAL QUALIFICATION OF HYBRID DIGITAL-PHYSICAL INTERNATIONAL SALES CONTRACTS UNDER THE LEX FORI

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Abstract This article explores the profound challenges that the Internet of Things (IoT) and "smart" products pose to the traditional taxonomies of private international law. As commercial transactions increasingly involve hybrid bundles of tangible hardware, embedded software, and continuous digital services, the threshold step of legal "characterization" or "qualification" has become highly complex. Operating primarily under the doctrine of the *lex fori*, courts apply domestic legal definitions to categorize these atypical contracts as either sales of goods or provisions of services. This study analyzes how the *lex fori* approach inevitably leads to conflicts of characterization across different jurisdictions, resulting in "limping" legal relationships. By examining comparative frameworks—such as the Predominant Purpose Test in the U.S., the "Goods with Digital Elements" paradigm in the EU, and the international regime of the CISG—this research highlights the urgent need to modernize domestic legal categories to prevent jurisprudential fragmentation and safeguard predictability in global digital trade.

Keywords: Characterization, legal qualification, *lex fori*, private international law, hybrid contracts, Internet of Things (IoT), smart goods, CISG, predominant purpose test.

1. Introduction

The emergence of the Internet of Things (IoT) has fundamentally disrupted the traditional taxonomies of private international law, as modern commercial transactions increasingly involve hybrid bundles of tangible hardware, embedded software, and continuous digital services.¹ These mixed transactions blur the rigid historical lines between the sale of goods and the provision of services, posing a profound analytical challenge for legal predictability.

In cross-border disputes, the legal "characterization" or "qualification" of these transactions is the essential first step for determining the applicable law (*lex causae*). Analytically, characterization is the allocation of a legal category to the factual questions raised before the court, ensuring that the correct choice of law rules can be applied to the dispute.²

This procedural gateway is governed primarily by the doctrine of the *lex fori* (the law of the forum). The foundational rationale here is that a judge, inherently trained in the laws of their own forum, cannot easily decide issues based on the rules of a foreign system without grasping in the dark, thereby necessitating the use of domestic internal laws to classify the dispute.³ However, from a critical doctrinal perspective, because domestic legal systems differ vastly in their substantive criteria for categorizing sales versus services, the rigid application of

¹ Stacy-Ann Elvy, 2017, Hybrid Transactions and the INTERNET of Things: Goods, Services, or Software?, <https://scholarlycommons.law.wlu.edu/cgi/viewcontent.cgi?article=4530&context=wlulr>

² Dr. Shivani Singh, 2018, Characterization of an International Conflict in Private International Law: The Concept and the Complications, https://www.indusedu.org/pdfs/IJREISS/IJREISS_1748_25493.pdf

³ Dr. Shivani Singh, 2018, Characterization of an International Conflict in Private International Law: The Concept and the Complications, https://www.indusedu.org/pdfs/IJREISS/IJREISS_1748_25493.pdf

the *lex fori* to modern hybrid digital-physical contracts generates a profound "conflict of characterization".⁴

Analytically, this conflict poses a severe threat to the harmony of international trade. Because private international law acts as a "meta-law," its rules require cross-border symmetry; yet, when a jurisdiction with a strictly tangible definition of "goods" applies its *lex fori*, it might characterize a software-heavy IoT contract as a service agreement, while another jurisdiction might view the exact same transaction as a sale of goods. In the United States, for instance, courts heavily rely on the "predominant purpose test" to classify mixed contracts, analyzing whether the core thrust of the transaction is for goods or services.⁵ This binary "all-or-nothing" classification is doctrinally inadequate for smart goods, resulting in "limping" legal relationships that fail to capture the continuous nature of digital performance and ultimately encourage rampant forum shopping.

Given that the distinction between goods, services, and software is blurring to the point of becoming indistinguishable, the traditional domestic binary approach is fundamentally ill-equipped. This article provides a comprehensive analysis of how the *lex fori* handles the qualification of hybrid digital-physical international sales contracts. It systematically evaluates comparative frameworks—such as the Predominant Purpose Test in the U.S. and the international sales approach under Article 3 of the United Nations Convention on Contracts for the International Sale of Goods (CISG)—to propose a modernized, autonomous mechanism that mitigates jurisprudential fragmentation.

2. Main Analysis

2.1 Characterization under National Legislation: The U.S. and UK Approaches

The difficulty of legally qualifying hybrid digital-physical contracts stems primarily from the fact that most domestic commercial codes were historically drafted to govern tangible, movable objects, creating a rigid binary between "goods" and "services".⁶ When courts apply the *lex fori* (the law of the forum) to characterize an international contract involving smart devices or the Internet of Things (IoT), they are forced to rely on these antiquated domestic frameworks (The Legal Qualification of Hybrid Digital-Physical International Sales Contracts Under the Lex Fori, 2025).

In the United States, the qualification of sales contracts is governed by Article 2 of the Uniform Commercial Code (UCC), which applies exclusively to "transactions in goods," defined as things that are movable at the time of identification to the contract.⁷ Because modern commercial contracts frequently involve a combination of hardware, embedded software, and ongoing digital services, U.S. courts predominantly utilize the "Predominant Purpose Test" (PPT) to classify the transaction⁸. Crystallized in the seminal case *Bonebrake v. Cox*, the PPT

⁴ Veronique Allarousse, 1991, A Comparative Approach to the Conflict of Characterization in Private International Law, <https://scispace.com/pdf/a-comparative-approach-to-the-conflict-of-characterization-3c68r1ehba.pdf>

⁵ Daniel P. O’Gorman, 2018, CONTRACT LAW’S PREDOMINANT-PURPOSE TEST AND THE LAW-FACT DISTINCTION, <https://www.fsulawreview.com/wp-content/uploads/2022/08/predominant-purpose-test.pdf>

⁶ Stacy-Ann Elvy, 2017, Hybrid Transactions and the INTERNET of Things: Goods, Services, or Software?, <https://scholarlycommons.law.wlu.edu/cgi/viewcontent.cgi?article=4530&context=wlulr>

⁷ Daniel P. O’Gorman, 2018, CONTRACT LAW’S PREDOMINANT-PURPOSE TEST AND THE LAW-FACT DISTINCTION, <https://www.fsulawreview.com/wp-content/uploads/2022/08/predominant-purpose-test.pdf>

⁸ Stacy-Ann Elvy, 2017, Hybrid Transactions and the INTERNET of Things: Goods, Services, or Software?, <https://scholarlycommons.law.wlu.edu/cgi/viewcontent.cgi?article=4530&context=wlulr>

asks whether the "thrust" or "purpose" of the agreement is reasonably stated as the rendition of a service with goods incidentally involved, or as a transaction of sale with labor incidentally involved (Mixed Contracts and the U.C.C.: A Proposal for a Uniform Penalty Default to Protect Consumers - openYLS). To make this determination, U.S. courts evaluate factors such as contractual language, the nature of the supplier's business, and the intrinsic worth or price allocation of the hardware versus the service components⁹. Critically, the PPT is an "all-or-nothing" approach under the Absorption Theory; if the sale of the physical hardware predominates, the UCC applies to the entire transaction, including the software and services, whereas if services predominate, the UCC is entirely excluded (The Classification of "Smart Goods" Under UCC Article 2 - The Reading Room - Georgia State University).

In stark contrast to the U.S. binary model, the United Kingdom has recognized the inadequacy of traditional classifications by actively legislating a "third category" of property. Under the Consumer Rights Act (CRA) 2015, the UK introduced "digital content"—defined as data produced and supplied in digital form—as a distinct, standalone legal category separate from both goods and services.¹⁰ However, when confronting hybrid transactions, the UK approach utilizes a functional integration rule: if digital content is incorporated into a physical product (such as the software within a smart television), the entire item is treated legally as "goods" if the digital content fails to conform to the contract.¹¹

2.2 Harmonization through International and Regional Standards: The EU and CISG

While domestic laws grapple with the rigidity of historical definitions, international and supranational standards have attempted to create modernized, autonomous mechanisms to characterize hybrid digital-physical transactions.

The European Union has advanced a highly functional approach to mitigate characterization conflicts within its Digital Single Market through two complementary directives implemented in 2019: the Sale of Goods Directive^{12,13}. The SGD established the paradigm of "Goods with Digital Elements" (GDE), defining them as any tangible movable items that incorporate or are inter-connected with digital content or services in such a way that the absence of the digital element would prevent the goods from performing their functions¹⁴. If a transaction meets this functional dependency criterion—such as a smartwatch that cannot operate without its corresponding mobile application—the entire hybrid bundle is characterized as a sale of goods under the SGD.¹⁵ Conversely, standalone digital content or services that are not integral to a physical good are captured separately under the DCSD.¹⁶

⁹ Daniel P. O’Gorman, 2018, CONTRACT LAW’S PREDOMINANT-PURPOSE TEST AND THE LAW-FACT DISTINCTION, <https://www.fsulawreview.com/wp-content/uploads/2022/08/predominant-purpose-test.pdf>

¹⁰ The Consumer Rights Act 2015: A Summary of Key Changes - Gough Square Chambers, 2015, <https://goughsq.co.uk/wp-content/uploads/2015/04/Consumer-Rights-Act-2015-Summary.pdf>

¹¹ The Legal Qualification of Hybrid Digital-Physical International Sales Contracts Under the Lex Fori, 2025

¹² SGD, EU 2019/771) and the Digital Content and Digital Services Directive (DCSD, EU 2019/770

¹³ Ulrich Magnus, 2025, Digital Goods and the CISG, https://www.researchgate.net/publication/392142100_Digital_Goods_and_the_CISG

¹⁴ Hogan Lovells, 2020, Connected cars in the light of the new Consumer Contract Law, <https://www.hoganlovells.com/en/publications/connected-cars-in-the-light-of-the-new-consumer-contract-law>

¹⁵ Productwise Bitesize: Sale of Goods Directive (EU) 2019/771 - Cooley, 2022, <https://products.cooley.com/2022/03/15/productwise-bitesize-sale-of-goods-directive-eu-2019-771/>

¹⁶ Goods with Digital Elements, Digital Content and Digital Services in Directives 2019/770 and 2019/771 - SSRN

At the global B2B level, the United Nations Convention on Contracts for the International Sale of Goods (CISG) provides an overarching uniform sales law, but its application to hybrid contracts hinges on the interpretative mechanism of Article 3(2).¹⁷ Article 3(2) states that the Convention does not apply to contracts in which the "preponderant part" of the obligations of the party who furnishes the goods consists in the supply of labor or other services.¹⁸ To determine this preponderant part, international tribunals typically rely on two primary methods: the "economic value criterion" (comparing the monetary value of the hardware versus the service/software components) and the "overall assessment approach" (evaluating the intent of the parties and the essential purpose of the transaction).¹⁹ Much like the U.S. PPT, if the goods portion is deemed preponderant, the CISG absorbs the service elements and governs the entire mixed contract uniformly,²⁰. However, unlike domestic tests, the CISG's preponderant standard must be interpreted autonomously, without recourse to national law counterparts, ensuring that local biases do not fracture the uniform application of international commercial law.²¹

2.3 Implementation Gaps and the Conflict of Characterization

When juxtaposing national legislation against international standards, critical implementation gaps emerge. The strict application of the *lex fori* in cross-border disputes forces judges to evaluate modern, highly servitized IoT transactions using domestic definitions that were never designed for the digital economy.²²

Analytically, this creates a profound conflict of characterization. For instance, a U.S. court applying the *lex fori* via the Predominant Purpose Test might classify a software-heavy industrial machine as a "service" contract if the software development and cloud-monitoring elements cost more than the raw metal hardware, thereby denying the buyer implied warranties of merchantability²³. Conversely, if the exact same dispute were heard in an EU jurisdiction applying the "Goods with Digital Elements" functional dependency test, or under the CISG's holistic "overall assessment" of party intent, it would likely be characterized as a sale of goods²⁴. This jurisprudential fracture leads to "limping" legal relationships—where a digital-physical product is legally recognized as "goods" in one country and "services" in another—ultimately incentivizing rampant forum shopping and undermining predictability in the global digital market (A Comparative Approach to the Conflict of Characterization in Private International Law - SciSpace)

2.4 Implementation Gaps in Traditional Characterization Tests

¹⁷ Sami Koponen, 2023, Applicability of the United Nations Convention on the International Sale of Goods (CISG) to Mixed Contracts, <https://erepo.uef.fi/bitstreams/99e86f97-0cbd-4d83-b554-1747648d98f9/download>

¹⁸ CISG Advisory Council Opinion No 04 – CISG-AC, 2004, <https://cisgac.com/opinions/cisgac-opinion-no-4/>

¹⁹ Sami Koponen, 2023, Applicability of the United Nations Convention on the International Sale of Goods (CISG) to Mixed Contracts, <https://erepo.uef.fi/bitstreams/99e86f97-0cbd-4d83-b554-1747648d98f9/download>

²⁰ Zlatan Meškić & Nevena Jevremović, 2021, FROM PRODUCT-CENTERED TO SERVICIZED INDUSTRY, https://iicl.law.pace.edu/sites/default/files/bibliography/823-article_text-1755-1-10-20211209.pdf

²¹ CISG Advisory Council Opinion No 04 – CISG-AC, 2004, <https://cisgac.com/opinions/cisgac-opinion-no-4/>

²² The Legal Qualification of Hybrid Digital-Physical International Sales Contracts Under the Lex Fori, 2025

²³ Stacy-Ann Elvy, 2017, Hybrid Transactions and the INTERNET of Things: Goods, Services, or Software?, <https://scholarlycommons.law.wlu.edu/cgi/viewcontent.cgi?article=4530&context=wlulr>

²⁴ Ulrich Magnus, 2025, Digital Goods and the CISG, https://www.researchgate.net/publication/392142100_Digital_Goods_and_the_CISG

The attempt to apply historical, binary domestic laws to modern, digitally integrated products reveals severe implementation gaps in private international law. When courts rely on the *lex fori* to categorize a hybrid transaction, they typically utilize traditional mechanisms like the Predominant Purpose Test (PPT) or the Gravamen of the Action Test. However, both frameworks are doctrinally inadequate for the smart economy.

Under the Predominant Purpose Test, courts attempt to determine whether the "thrust" of the agreement is the rendition of a service or the transaction of a sale.²⁵ The fundamental implementation gap here is its "all-or-nothing" nature; it forces a judge to declare an intertwined hybrid asset as either purely a good or purely a service, subsequently subjecting the entire transaction to a single body of law.²⁶ In the era of the Internet of Things (IoT), where hardware is entirely dependent on continuous cloud computing and software updates to function, attempting to isolate a "predominant" factor is an artificial exercise. For instance, if an IoT manufacturer limits its express warranties to the physical hardware but the embedded software fails, classifying the transaction predominantly as a "service" strips the buyer of crucial implied warranties of merchantability that normally accompany the sale of goods.²⁷

Alternatively, the Gravamen of the Action Test attempts to apply the law based on the specific component of the contract that caused the dispute—applying sales law if the hardware breaks, and service law if the software or installation fails. However, in modern "smart goods," technologies are increasingly intertwined, making it nearly impossible for computer scientists, let alone judges, to draw a clear distinction between a hardware defect and a software malfunction.²⁸ Furthermore, this test forces parties into costly litigation just to determine which law applies to their dispute, generating deep legal uncertainty at the time of contract formation.²⁹

At the international level, the CISG's Article 3(2) excludes contracts where the "preponderant part" of the obligations consists of the supply of labor or services. The implementation gap here stems from a lack of uniform methodology. Courts fracture the uniform application of the CISG by oscillating between two different methods: the "economic value criterion" (a strict comparison of prices) and the "overall assessment approach" (evaluating the subjective intent and the essential purpose of the transaction).³⁰

2.5 Analytical Case Studies: IoT, Smart Goods, and the Lex Fori Dilemma

To analytically demonstrate the conflict of characterization generated by the *lex fori*, we can examine specific commercial scenarios involving hybrid digital-physical sales.

Case Study 1: The "Bricked" Smart Hub and the Lex Fori Conflict Consider the real-world scenario of the "Revolv" smart home hub, a device purchased by consumers and businesses to

²⁵ Daniel P. O’Gorman, 2018, CONTRACT LAW’S PREDOMINANT-PURPOSE TEST AND THE LAW-FACT DISTINCTION, <https://www.fsulawreview.com/wp-content/uploads/2022/08/predominant-purpose-test.pdf>

²⁶ Stacy-Ann Elvy, 2017, Hybrid Transactions and the INTERNET of Things: Goods, Services, or Software?, <https://scholarlycommons.law.wlu.edu/cgi/viewcontent.cgi?article=4530&context=wlulr>

²⁷ Stacy-Ann Elvy, 2017, Hybrid Transactions and the INTERNET of Things: Goods, Services, or Software?, <https://scholarlycommons.law.wlu.edu/cgi/viewcontent.cgi?article=4530&context=wlulr>

²⁸ Chadwick L. Williams, 2018, The Classification of “Smart Goods” Under UCC Article 2, <https://readingroom.law.gsu.edu/cgi/viewcontent.cgi?article=2926&context=gsulr>

²⁹ Mixed Contracts and the U.C.C.: A Proposal for a Uniform Penalty Default to Protect Consumers - openYLS, 2025, <https://openyls.law.yale.edu/server/api/core/bitstreams/39e7aeb2-4c44-4898-978a-185717304af5/content>

³⁰ Sami Koponen, 2023, Applicability of the United Nations Convention on the International Sale of Goods (CISG) to Mixed Contracts, <https://erepo.uef.fi/bitstreams/99e86f97-0cbd-4d83-b554-1747648d98f9/download>

control connected electronics. The manufacturer later elected to permanently terminate the cloud services and software updates that supported the device, effectively "bricking" it and rendering the \$299 hardware useless.³¹ If a cross-border dispute arises, the outcome is entirely dictated by the *lex fori* characterization:

- In a U.S. jurisdiction applying the Predominant Purpose Test, the court might view the initial transaction as a sale of goods (the hub), but the failure relates to the service. Because the PPT applies one law to the whole contract, the buyer might unexpectedly lack recourse for the terminated service if the contract's warranty expressly excluded software and continuous services.
- Conversely, if the dispute were characterized under the European Union's Sale of Goods Directive (SGD, EU 2019/771), the hub would be legally classified as "Goods with Digital Elements" (GDE).³² Under the SGD's functional dependency test, the seller has a statutory duty to supply necessary updates and maintain the digital service to keep the physical good in conformity. The EU forum would hold the seller liable for a defective good, highlighting a profound jurisdictional split.

Case Study 2: Industrial Servitization and the CISG (The Orintix and Potato Chips Plant Cases) The complexity of characterization is equally disruptive in B2B industrial contracts. In the *S. r. l. Orintix v NV Fabelta Ninove* case, the dispute concerned the delivery and installation of a software system. The contract included hardware delivery but also required the seller to make continuous adjustments and updates to the software after the initial installation to ensure it operated with the buyer's legacy systems.³³ The court, bypassing a strict economic value comparison, utilized the "overall assessment approach" and concluded that the continuous service obligations formed the determinative task, thereby characterizing the contract predominantly as a service and excluding the application of the CISG entirely.

A parallel outcome occurred in the *Potato chips plant* case heard by the German Federal Supreme Court (BGH). The buyer ordered a highly expensive physical plant to produce potato chips. Economically, the tangible goods vastly outweighed the service costs. However, the seller was required to undertake complex installation and configuration to integrate the new machinery into an already functioning production line.³⁴ The court characterized the transaction as a contract for labor and services rather than a sale of goods, finding that the parties' core intent was the delivery of a fully functioning integrated system, not merely the transfer of physical machinery.

Analytical Synthesis These case studies expose the critical vulnerability of relying on the *lex fori* to qualify modern commercial contracts. As manufacturers transition from a product-centered model to a "servitized" industry—offering Product-Service Systems (PSS)—the

³¹ Stacy-Ann Elvy, 2017, Hybrid Transactions and the INTERNET of Things: Goods, Services, or Software?, <https://scholarlycommons.law.wlu.edu/cgi/viewcontent.cgi?article=4530&context=wlulr>

³² Ulrich Magnus, 2025, Digital Goods and the CISG, https://www.researchgate.net/publication/392142100_Digital_Goods_and_the_CISG

³³ Sami Koponen, 2023, Applicability of the United Nations Convention on the International Sale of Goods (CISG) to Mixed Contracts, <https://erepo.uef.fi/bitstreams/99e86f97-0cbd-4d83-b554-1747648d98f9/download>

³⁴ Sami Koponen, 2023, Applicability of the United Nations Convention on the International Sale of Goods (CISG) to Mixed Contracts, <https://erepo.uef.fi/bitstreams/99e86f97-0cbd-4d83-b554-1747648d98f9/download>

application of antiquated domestic tests generates erratic choice-of-law outcomes.³⁵ An identical cross-border transaction can be legally defined as a sale of goods in one state and a provision of services in another, destroying the predictability required for international trade and enabling widespread forum shopping.

3. Conclusion

The legal qualification of hybrid digital-physical international sales contracts under the *lex fori* represents a critical bottleneck in modern commercial jurisprudence. The traditional binary distinction between tangible goods and intangible services is doctrinally obsolete in the era of the Internet of Things (IoT) and Product-Service Systems (PSS).³⁶ While the *lex fori* doctrine provides a stable and familiar starting point for domestic judges, its rigid application to "smart" assets creates a profound conflict of characterization across jurisdictions.

Analytically, relying on antiquated domestic mechanisms like the Predominant Purpose Test forces an artificial severance of highly integrated technologies, frequently stripping commercial buyers of essential warranty protections when software or cloud services fail. This jurisprudential fragmentation generates "limping" legal relationships, destroys the predictability necessary for cross-border trade, and incentivizes opportunistic forum shopping. As the global economy becomes inextricably servitized, international private law must abandon retrospective, formalistic categorizations and embrace a functional, technologically neutral paradigm.

4. Recommendations

To mitigate the conflict of characterization and safeguard legal certainty in global digital trade, the following actionable, doctrinal recommendations are proposed:

1. Domestic courts and international tribunals should replace the "all-or-nothing" Predominant Purpose Test with a "Functionality Test" for hybrid IoT transactions. Under this approach, if the software and ongoing digital services are integral to the physical device's advertised operation, the entire transaction should be legally characterized under the unified regime of sales law.³⁷ This prevents the artificial separation of intertwined hardware and software, ensuring that implied warranties of merchantability apply to the smart asset as a holistic functional unit.
2. In disputes governed by international instruments like the CISG, adjudicators must strictly reject the *lex fori* characterization. Instead, they should utilize the "overall assessment approach" under CISG Article 3(2) autonomously, without recourse to domestic law counterparts. By evaluating the essential purpose and party intent of the product-service integration, tribunals can maintain the symmetry of private international law and prevent domestic biases from fracturing uniform commercial rules.³⁸

³⁵ Zlatan Meškić & Nevena Jevremović, 2021, FROM PRODUCT-CENTERED TO SERVITIZED INDUSTRY: PLACING PRODUCT-SERVICE INTEGRATION MODEL UNDER THE UMBRELLA OF THE UN CONVENTION, https://iicl.law.pace.edu/sites/default/files/bibliography/823-article_text-1755-1-10-20211209.pdf

³⁶ Zlatan Meškić & Nevena Jevremović, 2021, FROM PRODUCT-CENTERED TO SERVITIZED INDUSTRY, https://iicl.law.pace.edu/sites/default/files/bibliography/823-article_text-1755-1-10-20211209.pdf

³⁷ Stacy-Ann Elvy, 2017, Hybrid Transactions and the INTERNET of Things: Goods, Services, or Software?,

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³⁸ CISG Advisory Council, 2004, CISG Advisory Council Opinion No 04, <https://cisgac.com/opinions/cisgac-opinion-no-4/>

3. National legislatures must stop attempting to retrofit 19th-century commercial codes to 21st-century digital realities. Following the trajectory of the UK's recognition of "digital content" and the EU's "Goods with Digital Elements" (Directive 2019/771), states should draft legislation recognizing hybrid digital-physical bundles as a *sui generis* (unique) legal category.³⁹ This would establish bespoke rules for continuous digital performance, software updates, and data security that traditional sales and service laws lack.
4. Until universal harmonisation is achieved, commercial actors must leverage party autonomy to preempt *lex fori* conflicts. Practitioners should utilize the Hague Principles on Choice of Law in International Commercial Contracts to explicitly stipulate not only the governing law but also the agreed-upon legal *characterization* of the transaction within the contract itself (e.g., explicitly defining a hybrid machinery delivery as a "sale of goods").

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