

Open Working Group

# Data, not Paper

The Revolution  
We Keep Putting  
on Hold



**VISION PAPERS** SERIES

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*Design Enrico Costalli*

# DATA, NOT PAPER

*The Revolution We Keep Putting on Hold*

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## Part 1 — Preface: The Unfinished Revolution

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There is a photograph I keep on my desk. It shows a container ship being unloaded in Rotterdam: cranes tracing slow arcs against the sky, containers gliding in disciplined choreography. At first glance, it is a portrait of 21st-century efficiency. Look closer and you notice something out of place: a courier at the edge of the frame, clutching a manila envelope. Inside that envelope sits the bill of lading. Without it, the cargo does not move. The cranes hum, the crew waits, the ship racks up demurrage — all because a stack of documents, born digital in a dozen systems, had to be printed, stamped, signed, scanned, and physically delivered to someone who insists on holding the "original" in their hand.

I have spent most of my career watching this surreal ballet. And in the last five years, I have been watching something else: the convergence of forces that is finally making it obsolete.

### **The First Force: Law**

What began as an academic model — the UNCITRAL Model Law on Electronic Transferable Records, usually shortened to MLETR — is now being translated into national legislation. The United Kingdom's Electronic Trade Documents Act gives certain electronic trade documents the same legal effect as their paper equivalents. Singapore has amended its laws along similar lines. New York has updated its version of the Uniform Commercial Code so that certain digital assets can be treated like traditional paper instruments. Together, these changes start to replace the old idea of "possession of a piece of paper" with "exclusive control over a digital original".

### **The Second Force: Technology**

Electronic bills of lading — digital versions of the document that controls the release of cargo — have moved from pilot projects to mainstream use among major carriers. At the same time, industry groups in container shipping have developed common data and messaging standards. This is slowly turning isolated digital platforms into something more like a connected network, where information about goods can move between systems almost as smoothly as a physical container moves between ships, trucks, and trains.

### **The Third Force: Commercial Pressure**

The cost and risk of sticking with paper are no longer rounding errors that can be ignored. Large shipping lines have publicly committed to phasing out paper bills of lading within this decade. On high-value routes, a significant share of trade documents already moves in digital form. Every day spent insisting on wet ink and courier envelopes is no longer neutral; it is a choice to incur avoidable friction, delay, and risk.

And yet, the revolution remains strangely on hold.

In 2021, the International Chamber of Commerce launched a new rulebook called the Uniform Rules for Digital Trade Transactions, or URDTT. It was designed for a world where data, not paper, is the primary substrate of trade. It described how a new kind of

promise to pay, built on digital records and events, should work. Conceptually, it was exactly the sort of framework the industry will need. Practically, it arrived too early. Most legal systems still assumed paper. The digital platforms that could support legally robust "electronic originals" were immature. Many banks and corporates could not yet see what problem URDTT solved that a simple "electronic document" regime did not.

URDTT was, in other words, a cathedral built in a desert: the architecture was sound, but the surrounding ecosystem was not ready to live in it.

That ecosystem now looks very different. Laws based on MLETR have been enacted in key trading hubs. Digital platforms that manage electronic bills of lading and other transferable records have gained the confidence of insurers and banks. Industry standards have started to make those platforms interoperable instead of isolated. The desert is filling with cities. The question is no longer whether the original URDTT blueprint was directionally right; the question is how to adapt and occupy it now that the world finally resembles the environment it anticipated.

This paper exists because we are running out of time to pretend that staying in the paper world is a harmless preference. In a networked, data-rich economy, clinging to analogue processes is not standing still; it is sliding backward. The friction of documents is a silent, compounding tax on trade. Those who refuse to board the digital ship are not only missing out on efficiency gains; they are paying to maintain their own disadvantage.

What follows is not a technical manual, though it will dive into technical detail where needed. It is not a narrow legal commentary, though legal change is central to the story. It is meant as a map of how we arrived at this point, where we are now, and what needs to change for digital trade to become the norm rather than the exception. It explains why URDTT's first version struggled, why the broader ecosystem has finally caught up, and what a 21st-century "payment undertaking" — a digitally native promise to pay — must look like in a world that moves at the speed of data rather than the speed of couriers.

It also names something our industry often avoids: this transition will not treat everyone equally. Some actors profit from the delays, errors, and opaqueness of the paper era. Others stand to gain from building fast, transparent, programmable rails. The digital platforms we design and adopt now will become tomorrow's strategic choke points, every bit as consequential as ports and canals.

We have, in truth, already turned the last page of the paper era. We are no longer reading the old book; we are writing a new one. The next chapter will not be written in ink but in code — by those willing to step out of the comforting theatre of documents and into the harder, more honest world of data.

## Part II — A Century of Paper: How We Got Here

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For most of modern trade, paper was not a nuisance; it was the infrastructure. A bill of lading was not just a record of what had been loaded on a vessel. It was the legal key to the cargo, the document that determined who could claim the goods and on what terms. Invoices, inspection certificates, warehouse receipts, and transport documents together formed a paper chain that courts, banks, and traders all knew how to interpret.

The Uniform Customs and Practice for Documentary Credits (UCP) emerged in the 20th century to bring order to this world. Its most recent version, UCP 600, still underpins a large share of global trade finance. Its central idea is deceptively simple: banks deal with documents, not goods. A bank that issues a letter of credit does not inspect apples or steel coils; it examines the documents that purport to describe them. If the documents comply with the terms of the credit, the bank pays — even if the goods turn out to be defective.

That autonomy principle made cross-border commerce scalable. Exporters gained confidence that they would be paid if they produced the right documents. Importers gained comfort that payment would only be made if specific documentary conditions were met. Courts around the world came to trust this logic. The price of that success, however, was a deep attachment to the physical artefacts themselves. Originals, signatures, stamps, and endorsements became the anchors of trust.

For decades, this arrangement was entirely rational. There were no global digital networks. The only way to signal possession, endorsement, or transfer was with physical paper and ink. A courier carrying a bundle of documents was effectively carrying title and risk across oceans. The speed of trade was calibrated to the speed of couriers, telexes, and manual checking because there was no credible alternative.

What has changed is not the importance of trust, but the environment in which trust must operate. Containers now travel with sensors that stream location and condition data in real time. Port community systems can confirm loading events instantly. Banks run on core systems that reconcile balances in milliseconds. Yet the legal and operational backbone of many trade transactions still assumes that nothing is real until a stack of paper — or a digital photograph of that stack — lands on a desk.

The result is a growing mismatch. On one side, we have logistics and information flows designed for speed and transparency. On the other, we have legal and financial machinery still geared to artefacts that move slowly and are checked by hand. The legacy paper paradigm is no longer just quaint. It is a structural bottleneck: it dictates when cargo can be released, when financing can be unlocked, and how quickly risk can be transferred, even though the underlying data exists long before the documents do.

This is the world that frameworks like MLETR and URDTT are trying to rewrite. They do not change the need for clear evidence, autonomy, or enforceable promises. They change the medium in which those things live — from paper sheets to uniquely identifiable, controllable digital records — so that the legal and financial layers can finally move at the same pace as the physical and informational layers of trade.

## Part III — The Digital Mirage: Why eUCP Wasn't Enough

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When the industry introduced the Supplement to the Uniform Customs and Practice for Documentary Credits for Electronic Presentation — better known as eUCP — it was a careful step into the digital age. Instead of insisting that every required document be presented as paper, banks could now accept "electronic records": PDFs, images, or data files that replicated the look and content of traditional documents. For many practitioners, this felt like a revolution.

In reality, it was a refinement, not a reinvention. eUCP left the underlying logic of the system untouched. The bank still waits for a "presentation". A human still checks whether the documents — electronic or paper — are consistent with the terms of the letter of credit. The core questions remain: Is the bill of lading formatted correctly? Do the names and amounts match? Are all the pieces of the document set present and apparently genuine?

In other words, eUCP digitises the form of the document, not the logic of the transaction. It gives us faster ways to send the picture of a horse and carriage, but it does not give us a car. The process is still centred on bundles of narrative evidence that must be manually interpreted. There is no built-in notion of streaming data from sensors, no concept of an event automatically triggering an obligation, and no way to express conditions in a way that machines can act on without human mediation.

For institutions steeped in UCP 600, this conservatism was a feature, not a bug. eUCP preserved familiar roles and workflows. Legal departments could take comfort in the fact that the same concepts — presentation, facial compliance, refusal, and honour — still applied. Technology teams could frame implementation as "scanning and sending better" rather than "changing the foundation".

But that is precisely why eUCP has reached its limits. It does not address the real friction in modern trade: the gulf between the moment when the underlying events are known (goods loaded, temperature maintained, ship departed) and the moment when enough paper or electronic images have been assembled, couriered, and checked to let value move. It cannot take full advantage of the legal shift ushered in by MLETR, where a unique digital record can itself be the bearer of rights.

URDTT starts from a different premise. It does not ask, "How can we treat an electronic record as if it were a paper document?" It asks, "How can we structure a transaction so that digital records and data events are the primary objects the rules operate on?" That is why eUCP and URDTT are not competing answers to the same question. eUCP is a digital mirror of the paper paradigm; URDTT is an attempt to redraw the picture entirely.

For the many banks and corporates still operating comfortably within eUCP, this distinction is crucial. eUCP will remain useful wherever the business model is still document-centric. But it cannot, by design, deliver a fully data-driven trade process.

Treating it as the end point of digitisation risks mistaking a smoother version of the old world for the new world that is actually emerging.

## Part IV — The Legal Foundation: MLETR and National Adoption

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To move trade from paper to data, good software is not enough. The legal system has to accept that a digital record can do the same work that used to require a sheet of paper. That is the role of the MLETR (UNCITRAL Model Law on Electronic Transferable Records) and the national laws built on its ideas.

MLETR asks a simple but radical question: when can an electronic record be treated as the legal equivalent of a paper bill of lading, promissory note, or warehouse receipt? Its answer rests on two pillars.

### **Pillar One: Functional Equivalence**

Instead of insisting that an instrument must be on paper, the law looks at what the instrument needs to do: identify the document, show who is entitled to it, and allow that entitlement to be transferred. If an electronic record can reliably perform those functions using a "reliable method", it can be treated like its paper ancestor.

### **Pillar Two: Exclusive Control**

In the paper world, possession of the original document is what matters. In the digital world, many copies can exist, but only one record should count as the legal original at any point in time. MLETR therefore focuses on who has control over that record in a system that prevents double-use and makes transfers clear, final, and auditable.

Importantly, MLETR does not prescribe specific technologies. It does not mandate blockchain, a central database, or any particular vendor solution. It defines the outcomes — uniqueness of the record, integrity of its content, and the ability to identify who controls it — and leaves room for different technical architectures to satisfy those requirements as the market evolves.

Several key jurisdictions have now translated these principles into their own commercial laws. The United Kingdom's Electronic Trade Documents Act allows defined trade documents to exist purely in electronic form with the same legal status as paper. Singapore has amended its legislation to recognise electronic transferable records consistent with MLETR's concepts of control. New York has updated its version of the Uniform Commercial Code so that certain digital assets can be treated in a similar way to traditional paper instruments.

Taken together, these developments mean that on important trade corridors and in major financial centres, parties no longer have to "drop back to paper" simply to keep legal risk under control. A bill of lading or other transferable record can be created digitally, remain digital across borders, and still be enforceable as such in court.

This legal scaffolding does more than resolve edge cases. It gives banks the confidence to finance against digital originals, insurers the comfort to underwrite cargo controlled through electronic records, and technology providers a clear target for what it means to

be a 'reliable system'. In short, MLETR and its implementing laws lay the track that URDTT and modern Payment Undertakings need in order to run at full speed.

## Part VI — Why URDTT 1.0 Failed

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When the International Chamber of Commerce released the first version of the Uniform Rules for Digital Trade Transactions in 2021, the expectations around it were high. On paper, URDTT 1.0 promised exactly what many in the industry claimed to be looking for: a digital-native, instrument-agnostic rulebook capable of operating on data sets and events rather than on bundles of documents. In reality, however, it landed with a dull thud. Adoption was minimal, pilot usage was narrow, and most practitioners quietly went back to the comfort of UCP 600 and eUCP.

This was not because the rulebook was badly designed in principle. It failed because it was launched into an ecosystem that was not yet capable of supporting the kind of reality it described. In hindsight, three structural gaps stand out.

### 1. The Legal Track Was Not Yet Laid

URDTT assumed, implicitly, a world where electronic transferable records had firm legal footing: where a digital bill of lading or similar record could be created, controlled, and transferred with the same legal effect as its paper ancestor. In 2021, that world barely existed.

MLETR was still young and only partially adopted. Many major trading jurisdictions had not yet updated their commercial laws to recognise digital originals or to define concepts like "exclusive control" over an electronic record. In most places, the safest answer to the question "will a court treat this digital record like a paper bill of lading?" was "we don't really know yet."

That uncertainty matters. Banks are understandably reluctant to finance against an asset class whose legal status is unclear. Insurers hesitate to underwrite risks tied to instruments that might not hold up in court. Corporates do not want to base core flows on constructs that could evaporate in a dispute. URDTT 1.0 described a world in which digital records are legally robust objects. The surrounding legal environment had not yet caught up.

### 2. The Infrastructure Was Immature or Missing

URDTT also presupposed the existence of "reliable systems": digital platforms capable of issuing, holding, and transferring electronic originals in a way that satisfies MLETR-style requirements around singularity, integrity, and control. In practice, very few such platforms existed, and those that did were still early-stage.

A handful of electronic bill of lading providers and digital trade platforms were live, but:

- Not all had clear legal opinions tying their operation to MLETR-like concepts.
- Some had limited insurer or P&I club support.
- Most operated as closed ecosystems, with no meaningful interoperability between them.

- Banks and large corporates were only beginning to test them, often in small pilots rather than in core flows.

URDTT 1.0 was effectively asking the market to run a high-speed train on a track that was still being poured. The rules expected a level of platform maturity, standardisation, and confidence that simply wasn't there yet.

### **3. The Problem Was Not Widely Understood**

Perhaps the most important reason is also the least technical. In 2021, a large part of the trade finance community did not yet share a clear understanding of the problem URDTT was trying to solve.

For many practitioners, "digitisation" meant scanning paper and sending PDFs or – at most – using eUCP to present electronic documents instead of couriered ones. The distinction between an electronic copy of a document and a truly digital, data-conditioned transaction was not front of mind. In that mental model, URDTT looked like an elegant but abstract construct, whereas eUCP felt like a practical, incremental solution.

Put bluntly, URDTT was offering a bridge to a shore that many people did not yet believe existed. When faced with the choice between a familiar, document-centric process dressed in digital clothes and a genuinely new data-centric framework, most actors opted for the familiar.

### **A Cathedral in the Desert**

Taken together, these three factors explain why URDTT 1.0 behaved like a cathedral in a desert. The architecture was ambitious and internally coherent. The problem was that there were no roads leading to it, no surrounding city, and not enough people who wanted to relocate their daily lives there.

Since then, the landscape has changed. MLETR-style laws and equivalent national statutes have been enacted in key hubs. Platforms for electronic bills of lading and other digital originals have matured, gained insurer and bank approval, and begun to interoperate. The cost and risk of clinging to paper in a world of streaming data have become harder to ignore.

URDTT itself does not need to be discarded. The core insight — that trade finance rules should operate on data and events rather than on stacks of documents — remains valid. What is needed for its "second act" is not a complete redesign, but an honest reckoning with why the first act under-delivered: it tried to occupy a future that the legal, technical, and commercial ecosystem had not yet built.

## Part VII — The Payment Undertaking: A New Legal Animal

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At the centre of URDTT sits a construct that looks familiar at first glance but behaves very differently once you examine it closely: the Payment Undertaking. On the surface, it is "just" a promise by a financial institution to pay a beneficiary if certain conditions are met. That sounds like a traditional letter of credit. The similarity ends there.

In the documentary world, the bank's promise is tied to the presentation of documents. The obligation to pay arises when a stack of papers — or their electronic equivalents under eUCP — is presented and found to be compliant on its face. The focus is on what the documents look like and whether they match the terms of the credit. The documents are the unit of value: they are bundled, couriered, examined, accepted, or refused.

A Payment Undertaking under URDTT is built on a different substrate. It is data-centric and event-driven. The conditions for payment are expressed in terms of data sets and verifiable events rather than in terms of physical or scanned documents. Instead of saying "pay when these five documents are presented and compliant", the undertaking says, in effect, "pay when these specific data points from these identified sources confirm that the agreed events have occurred".

This has several consequences.

First, the object of examination changes. The bank is no longer in the business of visually checking signatures, stamps, and spellings. Its role shifts to confirming that data has been received from pre-agreed, authenticated systems — a port community system, a carrier's eBL platform, a sensor network — and that this data satisfies the conditions coded into the undertaking. The skill set moves from document checking to validating digital integrity.

Second, the promise becomes natively programmable. Because the Payment Undertaking is formulated around data conditions, it can be structured as a series of triggers along the life of a shipment. For example, a portion of the amount might be payable when data from the terminal and the carrier confirms that the goods have been loaded, another portion when the vessel reaches an agreed waypoint, and the balance when the electronic bill of lading has been transferred to the buyer. Each step is independent, defined in terms of verifiable events.

Third, the principle of autonomy is preserved but refined. Like a letter of credit, a Payment Undertaking remains separate from the underlying sale contract. The bank still does not arbitrate the quality of the goods. It looks only at whether the agreed data conditions have been met. What changes is the granularity and timing of those conditions: instead of a single, all-or-nothing moment of presentation, the promise can track the transaction more closely over time.

Finally, the Payment Undertaking is designed to live comfortably on top of the legal structures created by MLETR and similar laws. The digital records it references — such as an electronic bill of lading — are not merely attachments; they are legally recognised

objects whose control can be transferred in a way that courts and counterparties are prepared to accept. That gives the undertaking a firmer footing than any arrangement that relies purely on scanned paperwork.

Seen from a distance, a Payment Undertaking may look like just another bank promise. Up close, it is a different legal animal: one whose natural habitat is a world of structured data, authenticated systems, and programmable conditions, rather than a world of envelopes, stamps, and manual checklists.

## Part VIII — The Three Radical Shifts

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The move from a document-based world to a data-based one is not a cosmetic upgrade. It rests on three deep shifts in how obligations are created, checked, and executed.

### 1. From Compliance to Validation

In the traditional model, banks examine documents for facial compliance. A human compares names, dates, amounts, and descriptions across multiple papers and looks for discrepancies. A missing comma or a slightly different spelling can be enough to block payment. The underlying question is, "Do these documents look as they should under the credit?"

In a URDTT-style arrangement, the emphasis shifts to validation of data. Instead of asking whether a document appears correct, the system checks whether specific data elements from agreed sources match the conditions in the Payment Undertaking. A port system confirms that a container was loaded; a carrier platform confirms that an electronic bill of lading was issued and transferred; a sensor feeds temperature readings. The question becomes, "Can we confirm, from authenticated systems, that the required events actually occurred and the data has not been tampered with?"

This change reduces the role of subjective judgment about how a document "looks" and increases reliance on verifiable, machine-readable information.

### 2. The Death of the Mailing Period

Under UCP-style rules, there is always a gap between the physical movement of goods and the arrival of documents at the bank. The ship can be halfway across an ocean while the bill of lading is still in a courier bag. That mailing period is a zone of risk. Buyers and sellers resort to workarounds such as letters of indemnity to avoid cargo sitting idle while everyone waits for paper to catch up.

In a data-centric setup, that gap largely disappears. When a carrier issues an electronic bill of lading on a system that meets MLETR-style requirements, control over that record can pass from seller to buyer almost instantly. When a port system records that goods have been loaded, that information can reach the Payment Undertaking's validating engine in seconds. There is no separate journey for envelopes. The legal and financial consequences can follow closely on the actual events.

The result is not just speed for its own sake. Removing the mailing period reduces the need for risky interim arrangements and lowers the probability that cargo is stuck or released on the basis of incomplete information.

### 3. Enhanced Autonomy Through Granularity

The autonomy principle in classic documentary credits is binary. Once a complete, compliant set of documents is presented and accepted, the bank pays. If the set is

discrepant, it does not. The promise is independent of the sale contract, but the trigger is all-or-nothing.

A Payment Undertaking keeps that independence but introduces granularity. Because the undertaking is defined in terms of data and events, it can include multiple, separately testable conditions. For example:

- Release 20% of the amount when the terminal and carrier data confirm loading at the port of shipment.
- Release a further 30% when the vessel passes a specified waypoint and sensor data confirms that agreed conditions (such as temperature) have been maintained.
- Release the remaining 50% when the electronic bill of lading has been transferred to the buyer or its bank on a recognised platform.

Each of these steps is still independent of the underlying dispute about the goods themselves — the bank does not judge quality — but the payment profile can be much closer to the actual progress of the transaction.

Taken together, these three shifts — from document compliance to data validation, from mailing periods to near-real-time effects, and from a single trigger to programmable granularity — are what turn the Payment Undertaking from a slightly modernised letter of credit into something qualitatively different. They are also what make it a genuine bridge towards smart contracts and programmable money, rather than just another piece of digital paperwork.

## Part IX — A Transaction in Motion: The Future State

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To see what URDTT and a Payment Undertaking look like in practice, imagine a refrigerated fruit shipment from Latin America to Europe.

1. **Commercial agreement and rule choice.** The buyer and seller negotiate a sales contract. They agree that the trade will be supported by a Payment Undertaking issued by the buyer's bank and that the transaction will be governed by URDTT. These choices are recorded in the contract and in the bank's issuance of the undertaking.
2. **Issuance of the Payment Undertaking.** The buyer's bank issues the Payment Undertaking in favour of the seller. The undertaking is recorded on a platform that qualifies as a "reliable system" under the relevant MLETR-style law. The conditions for payment are expressed as data events: for example, loading at the port of shipment, successful passage of a waypoint, and transfer of an electronic bill of lading.
3. **Creation of the electronic bill of lading.** When the goods are loaded, the carrier issues an electronic bill of lading on the same platform or on an interoperable one. From that moment, control over the eBL represents control over the goods. Initially, the seller (or its bank) holds control.
4. **Data generation during shipment.** As the ship departs, multiple systems start emitting data: the port community system confirms 'loaded on board' with timestamps and identifiers; the carrier's standardised system tracks the vessel's voyage; sensors in the container stream temperature and location data to an agreed Oracle.
5. **Automated validation of conditions.** The platform continuously compares incoming data against the conditions defined in the Payment Undertaking. When a condition is met, the system records that fact and, if so configured, triggers the corresponding payment event automatically.
6. **Staged payments along the route.** Suppose the undertaking provides 30% payable when the goods are confirmed loaded on the vessel, 20% payable when the vessel passes a mid-ocean waypoint with compliant sensor data, and 50% payable when the eBL is transferred to the buyer or its bank. As each condition is validated by the system, the buyer's bank releases the corresponding amount to the seller without waiting for a physical presentation of documents.
7. **Transfer of control at destination.** When the ship arrives and discharge formalities are underway, the seller instructs the platform to transfer control of the eBL to the buyer (or to the buyer's bank). The reliable system ensures that once control passes, the seller can no longer use, pledge, or transfer the same eBL again.
8. **Completion and auditability.** At the end of the transaction, there is a complete, time-stamped record of who controlled the eBL at each point in time, which data

sources were consulted when each condition was satisfied or flagged as an exception and when each payment leg was executed. This record supports post-trade financing, compliance checks, and dispute resolution.

In this future-state transaction, nothing magical has happened to the underlying trade. Goods still move in containers on ships. But the financial and legal layer no longer waits passively for envelopes to arrive. It tracks the movement of goods as a series of verifiable data events and lets value move in lockstep with those events under clear rules that all parties have agreed in advance.

## **Part X — When Data Fails: Exceptions and Fallbacks**

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No matter how well designed the system, data will sometimes be missing, corrupted, or disputed. A credible URDTT-based setup has to assume failure and specify what happens next. The point is not to eliminate all problems, but to move from improvised workarounds to predictable, rule-based handling of exceptions.

### **1. When the Sensor Goes Silent**

Imagine that halfway through the voyage, the temperature sensor in a refrigerated container stops transmitting. In a traditional process, nobody may notice until the documents arrive and a dispute erupts over cargo condition. In a data-driven setup, the silence itself is an event.

The platform monitoring the feed can detect that messages have stopped and trigger an exception: automated payments linked to temperature conditions are paused, and the case is escalated to human review. The rules can prescribe fallback steps: draw on backup sensors, request a manual reading at the next port, or switch to a conservative assumption if no alternative data is available. Liability for losses can then be allocated according to whether parties met their agreed duties to maintain and monitor equipment, rather than on vague arguments about "who knew what when."

### **2. When the Data Does Not Match**

Data from different sources will sometimes conflict. The quantity loaded reported by the terminal may differ from what the seller declared; the vessel's position reported by one system may not align with another. In a document-centric world, such mismatches often only surface during manual checking, and the default reaction is to treat them as discrepancies that justify refusing payment.

Under URDTT, mismatches can be treated as managed exceptions rather than automatic failures. The rules can specify that when certain data points do not reconcile within defined tolerances, the system flags the issue, holds the affected payment leg, and opens a structured resolution window. Parties can then agree to accept the variation, correct the data, or invoke specific contractual remedies. The key is that the process is explicit, time-bound, and visible to all sides, rather than buried in ad hoc email exchanges.

### **3. When the API Does Not Answer**

Digital trade relies on connections to external systems: port community platforms, carrier systems, customs databases, and so on. Sometimes those connections will fail. An API may be down for maintenance, a network may be interrupted, or a third-party service may become temporarily unreachable.

A robust design does not pretend this will never happen. It defines grace periods and fallback sources. For example, if a primary Oracle does not respond within a certain time, the system may automatically query a secondary one, or it may switch to a "pending" state where certain obligations are suspended but not cancelled. If the outage persists beyond a defined threshold, the rules can shift control to human decision-makers, with clear guidance on how to document and justify any manual overrides.

#### **4. When the Oracle Is Disputed**

The most difficult failures are not technical but trust-related. One party may allege that a data source is compromised, biased, or simply wrong—for example, claiming that a carrier's system under-reports delays or that a sensor network has been tampered with.

URDTT on its own does not settle these disputes, but it can require that parties agree in advance on which Oracles are authoritative for which types of events and how challenges to their reliability will be dealt with. That may include:

- Criteria for approving and de-listing Oracles.
- Procedures for commissioning independent verification (such as surveyors or alternative data providers).
- Allocation of loss if a previously approved Oracle is later shown to have provided wrong data.

By forcing these questions to be addressed upfront, the framework reduces the scope for opportunistic disputes later.

#### **Designing for Failure, Not Just for Success**

In all these scenarios, the common thread is that failure is treated as a first-class design problem. Exceptions are not left to the imagination of individual banks, platforms, or relationship managers. They are anticipated in the rules of the game, with clear consequences for timing, payment, and liability.

That is one of the quiet but important advantages of a data-centric regime. Once events and conditions are expressed in structured form, it becomes easier to define, detect, and manage deviations from the expected path. Instead of hiding problems behind vague phrases and discretionary decisions, the system can surface them early and route them through agreed channels.

## **Part XI — New Roles, New Risks**

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As trade shifts from paper and static documents to data and digital records, every participant's role changes. The risks do not disappear; they move.

### **Sellers: From Document Assembly to Data Quality**

For exporters, the focus moves away from assembling a flawless stack of documents and towards ensuring that the underlying operational data is accurate, timely, and emitted from trusted systems.

- Their primary exposure becomes bad or incomplete data: wrong weights, mis-tagged containers, missing sensor feeds.
- Integration between their logistics, ERP, and trade platforms becomes a core competence, not an afterthought.
- A discrepancy that once could be fixed with a corrected document may now be a mis-firing data event that delays payment until it is resolved.

### **Buyers: From Discretionary Control to Codified Conditions**

Importers gain much richer visibility into what is happening in the supply chain, but they also commit more of their control into pre-agreed, coded conditions.

- The decision about when money moves is increasingly embedded in the structure of the Payment Undertaking and in the choice of Oracles and data sources.
- If the buyer is not careful in negotiating these conditions, they may find that payments are triggered in ways that do not match their internal risk appetite or commercial expectations.
- Managing 'programmable obligations' becomes as important as negotiating price and delivery terms.

### **Financial Institutions: From Document Checkers to Trust-System Managers**

Banks and other financial service providers shift from being primarily document handlers to being managers of digital trust frameworks. Their core tasks include defining and maintaining validation logic for data-driven undertakings, assessing and approving platforms as "reliable systems", and monitoring operational and cyber risks around the data flows that trigger payments. Traditional skills like discrepancy checking give way to capabilities in model governance, data integrity, and platform risk management.

This does not make banks less important; it makes them important in a different way. Their role as neutral, well-capitalised guardians of transactional trust becomes tied to the quality of the systems they oversee rather than to the stacks of paper they handle.

## **What It Means to Be a 'Reliable System'**

Across all these roles, one concept becomes central: the reliability of the platforms that host electronic transferable records and the data that drives Payment Undertakings. At a minimum, any such system should be able to demonstrate:

- Singularity: at any point in time, there is one authoritative version of a given electronic bill of lading or similar record. The same record cannot be used twice, pledged twice, or transferred to two parties at once.
- Exclusive control: it is always clear who controls the record, and transferring control is a well-defined, auditable operation. Once control moves from A to B, A can no longer use or transfer the record.
- Data integrity and audit trails: all changes to the record and all transfers of control are recorded in a way that makes unauthorised tampering evident.
- Robust identity: parties using the system can be reliably identified and authenticated. The system's notion of who is who can be mapped back to legal entities in the real world.

For banks and corporates assessing platforms, three practical questions follow naturally: How do you prevent the same electronic record from being used or pledged more than once? How can you prove, to a court or a regulator, who controlled a record at any given moment? How easily can your system interoperate with others without losing these guarantees?

## Part XII — The Road Not Yet Built: Interoperability

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Even with MLETR-style laws in place and URDTT providing a rules layer, digital trade can still get stuck if systems cannot talk to each other. The risk today is a landscape of well-designed islands: each bank, platform, or corridor running its own compliant environment but with limited ability to exchange digital originals or data across boundaries.

The consequences are familiar. Exporters and importers are forced to maintain multiple connections and sets of credentials. Banks have to support parallel processes for each ecosystem. Smaller players risk being locked into particular platforms, with reduced bargaining power and higher switching costs. Instead of one global shift from paper to data, we get a patchwork of incompatible pockets.

### Interoperability Has Three Dimensions

- Technical interoperability: systems use compatible data models and APIs so that an electronic bill of lading or a validated event can move between platforms without losing its legal and operational properties.
- Legal and rule interoperability: parties agree that digital records transferred across systems retain their status as "originals" and remain governed by consistent rules, rather than falling into a grey zone.
- Business and governance interoperability: operators of different platforms are willing to recognise each other's controls, identity frameworks, and audit trails, instead of treating everyone outside their own ecosystem as untrusted.

Addressing this issue requires more than a few API integrations. It means adopting open and widely published data standards for key trade documents and events, establishing common interface and security standards so that records can move safely between platforms without breaking the chain of control, and creating 'digital trade corridors' where governments, banks, and platform operators jointly commit to mutual recognition of digital originals and to minimum interoperability requirements.

If the industry fails to do this, the new rails risk becoming as fragmented and inefficient as the old ones — just with better user interfaces. If it succeeds, the combination of law, URDTT, and interoperable platforms can make digital trade feel less like navigating isolated city-states and more like travelling on a connected network.

## Part XIII — The Three-Speed World and the Battle for the Rails

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The transition from paper to data will not unfold evenly. For the next decade at least, trade will run at three very different speeds, often side by side.

### Speed One: The Digital-Native Express

At the front of the train are corridors and sectors where the pieces already line up: laws based on MLETR or equivalent are in force; electronic bills of lading and other digital originals are accepted by major carriers, banks, and insurers; platforms qualify as reliable systems and are starting to interoperate; and leading institutions are comfortable issuing Payment Undertakings and structuring transactions under URDTT.

On these lanes, trade can be executed almost entirely in data. Payment triggers are tied to events, cargo release is managed through electronic control of records, and manual interventions are the exception rather than the rule. This is where the full benefits of speed, transparency, and automation begin to show.

### Speed Two: The Paper-Thin Hybrid

A much larger part of the world will sit in a hybrid middle: some documents are electronic, but the legal framework is patchy; eUCP is used to send PDFs instead of couriers, yet underlying processes remain document-centric; platforms exist, but participants still feel the need to 'switch to paper' at certain points to be safe.

Here, trade looks digital on the surface but still depends on manual checks, local paper requirements, and workarounds. The risk is that this "paper-thin digitisation" becomes a comfort zone: good enough to claim progress but not transformative enough to unlock the real gains of a data-driven model.

### Speed Three: The Analogue Lagoon

In the slowest lane are markets and corridors where laws have not yet been updated to recognise digital originals; infrastructure is limited and connectivity is patchy; and risk appetite for new models is low, often for good reasons linked to governance, capacity, or politics. In these environments, paper remains the dominant medium, and any digital elements are typically simple scans or email attachments.

### The Battle for the Rails

Across all three speeds runs a deeper contest: who will build and control the rails of digital trade? Several models are emerging:

- State-backed or central-bank-linked infrastructures that embed trade flows into national or regional digital strategies.

- Bank-led consortia that aim to create interoperable rails focused on financing and risk distribution.
- Platform-centric models where large technology or logistics players build ecosystems around their own networks and standards.

Each model brings its own trade-offs in terms of openness, governance, and resilience. Systems designed primarily around national digital sovereignty may favour control and localisation over global interoperability. Systems driven by commercial platforms may optimise for adoption and features but risk creating new chokepoints where access and terms are set by private actors.

The strategic question for policymakers, banks, and corporates is not just how fast they move to digital, but on whose rails. The choices made now — which standards to back, which platforms to integrate, which legal frameworks to implement — will shape not only efficiency but also bargaining power, data access, and the ability to participate in future trade flows on fair terms.

## Part XIV — The Uncomfortable Truth: Winners and Losers

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It is comforting to frame the shift from paper to data as a pure efficiency story: fewer delays, less fraud, lower costs, better visibility. In that narrative, everyone wins. The reality is less tidy.

Systems that strip out friction also strip out the revenues and power positions that have grown up around that friction. This transition will redraw the map of who earns what, and for doing which kind of work.

On one side stand the "rentiers of friction". These are the firms and functions whose economics depend, directly or indirectly, on the slowness, ambiguity, and manual nature of today's trade processes. They include parts of banks that make steady fee income from handling documents, chasing discrepancies, and extending short-term liquidity while paper crawls through the system. They include law firms and advisors who are called in whenever minor misalignments between documents turn into major disputes. They include intermediaries whose main value is knowing how to navigate opaque procedural quirks in particular corridors. For all of them, a world in which data is clear, events are time-stamped, and obligations are executed automatically looks less like progress and more like a shrinking addressable market.

On the other side are the "architects of flow." These are the actors who take on the harder task of building and governing the new rails: platforms that qualify as truly reliable systems, banks that reposition themselves as managers of digital trust and risk rather than paper warehouses, logistics and technology providers that choose openness and interoperability over lock-in. Their economics are tied to keeping value moving — providing embedded finance at the moment a condition is validated, offering real-time risk analytics on live data, orchestrating multi-party workflows across borders. They earn because transactions are fast, transparent, and programmable, not because they are slow and obscure.

The uncomfortable truth for many incumbents is that it is very hard to be both. A bank cannot cling indefinitely to revenues from discrepancy fees and courier-based processes while also claiming to lead in URDTT-style, data-driven trade. A law firm cannot base its business on document disputes and simultaneously cheer for a world where those disputes dwindle because the underlying events are clearer and better recorded. A platform operator cannot sell itself as the champion of interoperability while designing its system to make exit costly and external connections painful.

This is not a moral judgement; it is a structural one. The incentives that reward rent-seeking around friction are fundamentally different from the incentives that reward investment in flow. At some point, institutions will have to choose which side of that line they stand on.

For those willing to cross the line and become architects of flow, the opportunity is significant. Someone has to design the data models, validation logic, and governance frameworks that will underpin digital trade for decades. Someone has to earn the trust

to hold and move the digital equivalents of bills of lading at scale. Someone has to translate legal frameworks like MLETR and rulebooks like URDTT into working, reliable infrastructure. The actors who take on that work will not just enjoy new revenue streams; they will set the defaults that everyone else will eventually live with.

For those who try to hold on to the old model as long as possible, the trajectory is equally clear. As more corridors move to digital, paper-based processes will become niche, then marginal, then a drag on competitiveness. The margins on friction will look attractive right up to the point where the volume disappears. When the music stops, the last custodians of the paper era will find that their expertise and fee structures are misaligned with how trade now actually works.

In that sense, the revolution is not only about replacing paper with data or documents with events. It is about shifting value from those who monetise the gaps and delays in the system to those who build and maintain the rails that make those gaps and delays unnecessary.

## Part XV — Epilogue: The Last Page Turns

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The story of trade has always been a story about how we record and move trust. For more than a century, we did that with paper: bills of lading that embodied title, letters of credit that embodied bank promises, certificates and invoices that embodied facts about goods and parties. We built a global system on the assumption that nothing was real until it was written, stamped, and physically held.

That assumption is now breaking down. The same journey that used to be captured in a handful of documents is today traced in thousands of data points: sensor readings, port events, system logs, digital signatures, and transfer records. Legal frameworks like MLETR have recognised that certain digital records can stand in for paper without loss of legal effect. Rulebooks like URDTT have begun to describe how obligations can be tied directly to those records and events. The tools to let data carry trust are finally here.

What remains is the human part of the transition.

For regulators and lawmakers, the task is to continue turning model laws and pilot projects into predictable, widely usable frameworks. That means aligning commercial codes with MLETR-style concepts, recognising electronic trade documents across borders, and encouraging interoperability rather than fragmentation. It also means supervising new rails with the same seriousness that was once applied to physical infrastructure like ports and payment systems, without freezing innovation in the process.

For banks and other financial institutions, the choice is whether to remain primarily handlers of paper (and its electronic facsimiles) or to embrace the role of stewards of data-driven trust. The comparative advantage of a well-regulated financial institution is not its ability to move envelopes; it is its ability to underwrite risk, manage obligations, and stand behind promises. In a URDTT world, that advantage is expressed through designing and operating Payment Undertakings that are transparent, robust, and aligned with the new legal environment.

For platform operators and technology providers, the responsibility is to build rails that are reliable, fair, and open enough to support an ecosystem, not just a captive customer base. That means meeting the standards implied by MLETR and URDTT, but also committing to interoperability, clear governance, and exit options. The systems they design now will shape who can participate in digital trade, on what terms, and under whose rules.

For traders themselves — buyers and sellers — the shift is more practical but no less profound. It involves investing in data quality instead of paper perfection, in integration instead of manual workarounds, and in understanding how their commercial terms are expressed in code as well as in contracts. It means accepting that some control moves into rules and systems and insisting that those rules and systems are understandable and contestable.

The last page of the paper era is already turning. We will still see paper for years to come, just as steam engines ran alongside diesel for a while. But the direction of travel is

clear. The centre of gravity is moving from documents to data, from couriers to connections, from visual inspection to validation.

The next chapter of trade will not be written in ink. It will be written in code — in the protocols, standards, and rule sets that define how digital records are created, controlled, and used to move value. The real question is not whether that chapter will be written but who will be in the room when the first draft is agreed upon and whose interests it will reflect.

*Those who choose to help design and operate the new rails now will live in a world they have helped shape. Those who wait for a perfect, fully settled end state will inherit whatever others have decided for them.*

# Glossary

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## **API (Application Programming Interface)**

A defined set of protocols and tools that allows different software systems to communicate with one another. In digital trade, APIs connect port systems, carrier platforms, banks, and logistics providers so that data can flow between them without manual re-entry.

## **Autonomy Principle**

A foundational rule in documentary credit law: a bank's obligation to pay under a letter of credit is independent of the underlying sale contract. The bank examines documents (or data conditions) only, and does not adjudicate disputes about the quality or delivery of goods. URDTT preserves this principle while extending it to data-driven Payment Undertakings.

## **Bill of Lading (BoL)**

A document issued by a carrier acknowledging receipt of goods for shipment. It serves simultaneously as a receipt, a contract of carriage, and — crucially — a document of title. Whoever holds the original bill of lading can claim the cargo at the port of destination. Its function as a transferable title document is what makes digitising it legally complex.

## **Demurrage**

A charge levied on a shipper or charterer when a vessel is detained in port beyond the agreed time for loading or unloading. Delays caused by the late arrival of paper documents are a common source of demurrage costs.

## **DCSA (Digital Container Shipping Association)**

An industry body established by major container shipping lines to develop and promote common data and technology standards across container shipping. DCSA's work on electronic bill of lading (eBL) standards is central to making different digital platforms interoperable.

## **Documentary Credit**

See Letter of Credit.

## **eBL (Electronic Bill of Lading)**

A digital version of the bill of lading that exists on a platform qualified to hold and transfer electronic transferable records. Unlike a scanned PDF of a paper bill of lading, a true eBL confers legal title over cargo and can be transferred between parties electronically, provided the underlying platform meets the functional equivalence and exclusive control requirements of frameworks such as MLETR.

## **eUCP (Supplement to UCP for Electronic Presentation)**

A supplementary set of rules issued by the International Chamber of Commerce that allows banks to accept electronic records — such as PDFs or other digital files — in place of paper documents under a letter of credit. eUCP digitises the presentation of documents but leaves the underlying documentary logic of UCP 600 unchanged.

## **Exclusive Control**

A concept central to MLETR and to the legal treatment of electronic transferable records. In the paper world, holding the physical original is what confers rights. In the digital world, MLETR replaces physical possession with exclusive control: at any point in time, one and only one party should be identifiably in control of an electronic record, with no possibility of the same record being simultaneously used, pledged, or transferred to another party.

## **Facial Compliance**

The standard applied by banks when examining documents under a letter of credit. Banks check whether the documents presented appear on their face to comply with the terms of the credit — they do not verify the underlying commercial reality or inspect the goods themselves. A document may be facially compliant even if the goods it describes are defective.

## **Functional Equivalence**

The principle, embedded in MLETR, that an electronic record should be treated as the legal equivalent of its paper counterpart if it can reliably perform the same functions: identifying the record, indicating who is entitled to it, and enabling that entitlement to be transferred. Functional equivalence is technology-neutral: it sets outcomes rather than mandating specific technical solutions.

## **Letter of Credit (LC)**

A payment instrument issued by a bank (the issuing bank) on behalf of a buyer (the applicant), promising to pay a specified amount to a seller (the beneficiary) upon presentation of documents that comply with the credit's terms. Letters of credit are governed by UCP 600 and enable cross-border trade by substituting bank credit for buyer credit.

## **Letter of Indemnity (LoI)**

A contractual undertaking, typically issued by a seller or shipper, indemnifying a carrier or buyer against losses arising from releasing cargo without the original bill of lading. Letters of indemnity are widely used as a workaround when cargo arrives at the destination before the paper bill of lading does — a gap that electronic bills of lading are designed to eliminate.

## **MLETR (UNCITRAL Model Law on Electronic Transferable Records)**

A model law adopted by the United Nations Commission on International Trade Law in 2017. MLETR provides a legal framework for treating electronic records as the functional equivalents of paper transferable documents — including bills of lading, promissory notes, and warehouse receipts. It is not itself binding law; jurisdictions must enact it (or equivalent legislation) into their own legal systems. Key adopters include the United Kingdom, Singapore, and several US states.

## **Oracle**

In the context of URDTT and data-driven trade, an Oracle is a trusted, pre-agreed external data source whose outputs can be used to validate whether a condition in a Payment Undertaking has been met. Oracles may include port community systems, carrier platforms, sensor networks, customs databases, or any other authenticated data provider. The reliability and neutrality of Oracles is a critical governance question in URDTT-based transactions.

## **P&I Club (Protection and Indemnity Club)**

A mutual insurance association that provides cover to shipowners and operators for third-party liabilities, including cargo claims, pollution, and crew-related risks. P&I clubs' willingness to recognise electronic bills of lading on specific platforms is an important indicator of market confidence in those platforms' reliability.

## **Payment Undertaking**

The central instrument in URDTT. A Payment Undertaking is a bank's promise to pay a beneficiary when specified data conditions — rather than document presentations — are satisfied. Unlike a letter of credit, it is event-driven and can be structured to release payment in stages as verifiable milestones are reached during a shipment. It is designed to operate natively in a data-centric environment supported by MLETR-style laws.

## **Port Community System (PCS)**

A neutral electronic platform that connects multiple parties in a port — including terminal operators, shipping agents, customs authorities, and freight forwarders — allowing them to exchange information about vessel arrivals, cargo loading, and customs clearances. PCS data is increasingly used as a trusted Oracle in digital trade transactions.

## **Reliable System**

The standard that a digital platform must meet under MLETR-style frameworks in order to host and transfer electronic transferable records with legal effect. A reliable system must ensure the singularity of records (no double-use), exclusive control (clear identification of who holds the record at any time), integrity of content (tamper-evidence), and robust identity verification of participants.

## **Smart Contract**

A self-executing program stored on a distributed ledger or other computational platform that automatically enforces the terms of an agreement when pre-defined conditions are met, without requiring human intermediaries. Payment Undertakings under URDTT share conceptual similarities with smart contracts — both are programmable and event-driven — but Payment Undertakings operate within established commercial law frameworks and do not require blockchain infrastructure.

## **UCP 600 (Uniform Customs and Practice for Documentary Credits)**

The primary international rulebook governing letters of credit, published by the International Chamber of Commerce. Version 600, in force since 2007, sets out the rights and obligations of banks, applicants, and beneficiaries in documentary credit transactions. Its central principle — that banks deal with documents, not goods — underpins the global trade finance system.

## **URDTT (Uniform Rules for Digital Trade Transactions)**

A rulebook published by the International Chamber of Commerce in 2021, designed to govern trade finance transactions that are structured around data sets and digital events rather than paper documents. URDTT introduces the Payment Undertaking as its core instrument and is intended to complement — not replace — MLETR-style legal frameworks. Its first version saw limited adoption; a second iteration is expected to benefit from the more mature legal and technical ecosystem that has developed since 2021.

## **Warehouse Receipt**

A document issued by a warehouse operator acknowledging that specified goods have been deposited. Like a bill of lading, a warehouse receipt can function as a document of title, allowing the holder to claim or transfer ownership of stored goods. MLETR's framework applies equally to electronic warehouse receipts.

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The greatest danger  
in times of turbulence  
is not the turbulence itself,  
but to act with  
yesterday's logic

— Peter Drucker

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