

DANMARKS NATIONALBANK

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Assessment of Kronos2

- Danmarks Nationalbank's payment and settlement system, Kronos2, has a high level of compliance with international organisation, risk management, safety, efficiency and contingency standards.
- Ongoing efforts are made to strengthen Kronos2 risk management and security, but the requirements are also tightened in line with the evolving threat landscape and increased technical complexity.
- The assessment of Kronos2 has identified a potential for improvement in areas such as governance, risk management and contingency. Danmarks Nationalbank has planned or initiated work in these areas.

CONTENTS

- 2 OVERALL ASSESSMENT
- 4 GENERAL ORGANISATION
- 5 CREDIT AND LIQUIDITY RISK MANAGEMENT
- 5 SETTLEMENT
- 5 DEFAULT MANAGEMENT
- 6 GENERAL BUSINESS RISK
- 6 OPERATIONAL RISK
- 7 ACCESS
- 8 EFFICIENCY
- 8 TRANSPARENCY

Central infrastructure

kr. 250 billion

the average value of transactions completed in Kronos2 every banking day.

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Safe and efficient

Kronos2

has a high level of compliance with international standards.

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When financial institutions send payments to each other in Danish kroner, they do so through Kronos2, which is Danmarks Nationalbank's system for settling payments between financial institutions. These payments are often large and time-critical in nature.

Most Danish banks and mortgage credit institutions hold accounts with Danmarks Nationalbank in the same way private individuals hold accounts with commercial banks. In addition to the banks, five critical payment and settlement systems hold accounts with Danmarks Nationalbank, because Kronos2 is also being used to settle net positions from these connected systems (for example retail payment systems).

Kronos2 is a central system in the Danish financial infrastructure. On average, transactions with a combined value of around kr. 250 billion are completed in Kronos2 every banking day.¹ Major failures or breakdowns in Kronos2 could damage trust in the financial system and, at worst, threaten financial stability. As a result, it is important that Kronos2 complies with current international safety and efficiency standards. To verify compliance, Danmarks Nationalbank has carried out an assessment of Kronos2 in accordance with CPMI-IOSCO²'s Principles for Financial Market Infrastructures, PFMI.³ The assessment shows that Kronos2 is a safe and efficient system. However, payment system requirements are constantly evolving, see Box 1, and a potential for improvement has been identified in some areas.

Overall assessment

The assessment shows that Kronos2 has a high level of compliance with international organisation, risk management, security, efficiency and contingency standards. The assessment of Kronos2's compliance with the individual principles is shown in Box 2.

Danmarks Nationalbank's oversight

Danmarks Nationalbank oversees that payments and financial transactions in Denmark can be effected safely and efficiently. Its oversight comprises the core systems and solutions in the Danish payments infrastructure:

- Kronos2 (interbank payments)
- the Sumclearing, Intradagclearing and Straksclearing (retail payments)
- Euronext Securities Copenhagen (securities transactions)
- Dankort, Betalingsservice and credit transfers (the most important payment solutions)
- International systems of relevance to Denmark.

Danmarks Nationalbank's oversight is based on international standards and guidelines and is described in its oversight policy ([link](#)).

Development in payment system requirements

Box 1

The payment system requirements are continuously being tightened in line with technological advances and changes in the threat landscape. As a result, the implementation of the requirements of the PFMI will also change over time. This means that some areas that were previously PFMI compliant may no longer be found to be in full compliance with the requirements. This applies to some areas in the assessment of Kronos2 compared to the 2016 assessment of Danmarks Nationalbank's previous payment system, Kronos.¹

New guidelines based on best practice address the rapid development. For example, in May 2018, the CPMI published a strategy² to help strengthen endpoint security to reduce the risk of criminal transactions in central payment systems. The strategy has helped define how the relevant requirements of the PFMI should be interpreted in relation to the new threat landscape.

- 1 Danmarks Nationalbank, Assessment of Kronos, Danmarks Nationalbank Other publications, 1 July 2016 ([link](#))
- 2 CPMI, Reducing the risk of wholesale payments fraud related to endpoint security, May 2018 ([link](#)).

1 This includes interbank payments, transfers to settlement systems, monetary policy operations and the settlement of net positions from the settlement systems.

2 The CPMI-IOSCO principles are published by the Bank for International Settlements, BIS, and the International Organization of Securities Commissions, IOSCO. The Committee on Payment and Market Infrastructures, CPMI, is the BIS working committee that has helped to develop the principles.

3 CPMI-IOSCO, Principles for Financial Market Infrastructures (PFMI), April 2012 ([link](#)).

Kronos2 has a high level of compliance with international standards

Box 2

The assessment of Kronos2 was based on CPMI-IOSCO's Principles for Financial Market Infrastructures, PFMI, from April 2012. PFMI places requirements on all areas of a payment system – both the legal basis, the general organisation, IT security and the detailed management of all risks that may arise in connection with payment settlement.

Danmarks Nationalbank has used the following scale and categories to define the degree of compliance with PFMI:

- **Observed** is used when all essential criteria have been met and any deficiencies or weaknesses are not issues of concern and are minor, manageable and of a nature that the payment system could consider taking them up in the normal course of its business.
- **Broadly observed** is used when the criteria have been largely met and one or more issues of concern have been identified which should be addressed within a given deadline.
- **Partly observed** is used when the criteria have been partly met and one or more issues of concern that could become serious if not addressed in a timely manner has been identified. The payment system should accord a high priority to address these issues.
- **Not observed** is used when the criteria have not been met and one or more serious issues of concern that warrant immediate action has been identified. Therefore, the payment system must accord the highest priority to address these issues in a timely manner.
- **Not applicable** is used when the principle is not applicable because of the particular legal, institutional, structural, or other characteristics of the payment system.

Below is an overview of Kronos2's compliance with the individual principles.

Organisation

Principle 1 – Legal basis	Observed
Principle 2 – Governance	Broadly observed
Principle 3 – Framework for the comprehensive management of risks	Broadly observed

Credit and liquidity risk management

Principle 4 – Credit risk	Observed
Principle 5 – Collateral	Observed
Principle 6 – Margin	Not applicable
Principle 7 – Liquidity risk	Broadly observed

Settlement

Principle 8 – Settlement finality	Observed
Principle 9 – Money settlements	Observed
Principle 10 – Physical deliveries	Not applicable

Central securities depositories and exchange-of-value settlement systems

Principle 11 – Central securities depositories	Not applicable
Principle 12 – Segregation and portability	Not applicable

Default management

Principle 13 – Participant-default rules and procedures	Observed
Principle 14 – Segregation and portability	Not applicable

General business risk management

Principle 15 – General business risk	Observed
Principle 16 – Custody and investment risks	Observed

Operational risk

Principle 17 – Operational risk	Broadly observed
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Access

Principle 18 – Access and participation requirements	Broadly observed
Principle 19 – Tiered participation arrangements	Observed
Principle 20 – FMI links	Not applicable

Efficiency

Principle 21 – Efficiency and effectiveness	Observed
Principle 22 – Communication procedures and standards	Observed

Transparency

Principle 23 – Disclosure of rules, key procedures, and market data	Observed
Principle 24 – Disclosure of market data by trade repositories	Not applicable

CPMI-IOSCO's PFMI contains 24 principles, but not all principles are relevant to Kronos2. Kronos2 fully observes 12 of 17 assessed principles, while five principles are considered to be 'broadly observed' – see Box 2. One or more potential improvements have been identified for these principles, which should be addressed within a set timeframe.

The assessment is based on a review of Kronos2 based on a number of questions formulated by CPMI-IOSCO regarding compliance with the specific requirements of the principles.⁴ In this connection, rules, organisational charts, business procedures, risk assessments, descriptions of controls and security measures etc. have been reviewed.

The degree of Kronos2's observance of the individual principles is described in more detail below, including the identified potential for improvement and planned or initiated initiatives to address it.

General organisation

Principle 1 – Legal basis; **observed**
Principle 2 – Governance; **broadly observed**
Principle 3 – Framework for the comprehensive management of risks; **broadly observed**

Principles 1-3 concern the organisation around Kronos2, including the legal basis, governance and framework for the comprehensive management of risks. Kronos2 observes Principle 1, while Principle 2 and Principle 3 are considered to be broadly observed.

Kronos2 has a clear legal basis that is enforceable in all relevant jurisdictions, and all activities are subject to Danish law. The contractual basis between the participants and Danmarks Nationalbank is set out in Danmarks Nationalbank's terms and conditions for accounts', which are available on Danmarks Nationalbank's website.

Danmarks Nationalbank has policies and procedures to identify, measure, monitor and manage risks related to Kronos2. The work is based on Danmarks Nationalbank's Risk and Security Policy, whose general principles are specified in Danmarks Nationalbank's risk strategy and appetite. Responsibility for the risk management work follows international standards with the establishment of three organisational lines of defence; operational units, control and compliance function and internal audit. A risk committee has been established to decide on prioritisation and risk management. The risk committee continuously reports to the senior management on the risk landscape and relevant matters. In addition, risk management related to Kronos2 is anchored in a sub-committee.

Potential for improvement of governance and risk management

A potential for improvement of governance and risk management has been identified.

Danmarks Nationalbank will strengthen its ongoing reporting to the management on risk management and countermeasures. Likewise, it will be ensured that the management provides clear guidelines on the implementation of Danmarks Nationalbank's Risk and Security Policy on an annual basis, and that the objectives and projects set out in this process are followed up. The aim is to provide a clearer framework for work at operational level and a better platform for monitoring compliance with the policy.

In addition, Danmarks Nationalbank is working to strengthen risk management by further formalising and anchoring responsibility for the day-to-day risk management with the system owner in the first line of defence. Specifically, the aim is to extend the involvement and follow-up of the system owner in relation to compliance-related and operational risks. At the same time, this will allow the second line of defence to step back, thereby strengthen its independence.

⁴ The questions can be found in the report 'Principles for market infrastructures: Disclosure framework and assessment methodology', December 2012 ([link](#)).

Credit and liquidity risk management

Principle 4 – Credit risk; **observed**
Principle 5 – Collateral; **observed**
Principle 7 – Liquidity risk; **broadly observed**

Principles 4-7 concern credit and liquidity risk management. Kronos2 complies with Principle 4 on credit risk and Principle 5 on collateral, while there is potential for improvement of Principle 7 on liquidity risk.

Danmarks Nationalbank incurs a credit risk on the participants in Kronos2, who are offered credit against collateral. Credit risk is reduced by providing credit only against collateral in the form of high-quality assets and by using appropriate haircuts when calculating the collateral value of the assets. The collateral value is calculated on a daily basis, based on updated market prices, and if a security has not been traded, a synthetic price is used. Risks are managed in a fixed framework, and the risk assessment of Danmarks Nationalbank's collateral is updated on a regular basis.

Participants in Kronos2 do not incur a credit risk on each other because each payment is settled individually and instantly. On the other hand, participants do incur a liquidity risk, as payments can be delayed if the sender lacks liquidity. Liquidity risk between participants is limited through free access to intraday credit against collateral, and ample liquidity among the participants ensures that payments are generally settled smoothly via Kronos2.

Previous liquidity stress tests have shown that payment settlement and participants' liquidity are sufficiently resilient to various forms of stress. The same conclusion is expected to apply to Kronos2.

Potential for improvement of liquidity risk

Liquidity stress tests using Kronos2 data have yet to be completed. Danmarks Nationalbank is working on it and will establish a stress test programme to ensure that liquidity stress tests using Kronos2 data can be conducted on a regular basis.

Settlement

Principle 8 – Settlement finality; **observed**
Principle 9 – Money settlements; **observed**

Principle 8 and Principle 9 deal with settlement finality and money settlements. Kronos2 observes both principles.

Settlement in Kronos2 is protected by the Settlement Finality Directive. According to the Directive, a transaction is final and irrevocable when the sender's account is debited and the recipient's account credited. The point at which a payment is final is defined in the terms and conditions for accounts, and finality is enshrined in Danish law.

Money settlement, i.e. the settlement of payments in Kronos2, takes place on accounts with Danmarks Nationalbank. This means that payments are settled in so-called central bank money.

Default management

Principle 13 – Participant-default rules and produces; **observed**

Kronos2 observes Principle 13, which concerns participant-default rules and produces.

Clearly defined rules and procedures are in place to manage a participant default, resolution or operational failure, which include guidelines on coordination between relevant parties and timely communication. The procedures are formalised in business procedures and are continuously tested.

In the event of a participant default that prevents the participant from executing and receiving payments,

Danmarks Nationalbank may assist the participant in executing payments through emergency procedures. In more serious situations, where, for example, one of the largest participants experiences a prolonged operational failure affecting payment settlement in Kronos2, Danmarks Nationalbank's contingency plan may be activated. FSOR's contingency plan may also be activated if there is a risk that the operational failure may spread throughout the sector.

Rules on the use of emergency procedures and rules on the realization of collateral⁵ can be found in Danmarks Nationalbank's terms and conditions for accounts. Rules and procedures for managing a participant default are described in Danmarks Nationalbank's description of Kronos2 in relation to international principles, which is available on Danmarks Nationalbank's website.⁶

General business risk

Principle 15 – General business risk; **observed**
Principle 16 – Custody and investment risks; **observed**

Principle 15 relates to the management of general business risk, i.e. risks that may lead Danmarks Nationalbank to incur losses in connection with the operation of Kronos2. Principle 16 concerns Kronos2's securities in custody accounts with Euronext Securities Copenhagen, ES-CPH, formerly VP Securities A/S. Kronos2 complies with the requirements of Principles 15 and 16.

General business risks are identified and assessed on an ongoing basis. Risks are reduced, among other things, by Kronos2 having a pricing model where the price of participating in Kronos2 is adjusted so that the revenue received from the participants matches the costs of running the system.

As Kronos2 is a central bank-owned payment system, there is no need to hold liquid assets specifically to cover business risk and to support a recovery or resolution plan.

Securities provided by the participants as collateral for intraday credit in Kronos2 are held in safe custody with ES-CPH, which Danmarks Nationalbank is assured of through the Danish Financial Supervisory Authority's supervision and Danmarks Nationalbank's oversight of ES-CPH.

Danmarks Nationalbank has prompt access to securities held in custody accounts pledged for credit to Danmarks Nationalbank. This also applies in the event of a participant default, as Danmarks Nationalbank has entered into an agreement on prompt realization of the pledged securities with the individual account holders. Risks associated with collateral at ES-CPH are assessed on an ongoing basis.

Operational risk

Principle 17 – Operational risk; **broadly observed**

⁵ In the event that a participant fails to meet its obligations, Danmarks Nationalbank has the right to sell or take over the participant's pledged collateral in order to repay the participant's debt to Danmarks Nationalbank.

⁶ Danmarks Nationalbank, Description of Kronos2 in relation to international principles, *Danmarks Nationalbank Other publications*, July 2021 ([link](#)).

Principle 17 concerns operational risk management in relation to Kronos2, including internal risks and risks associated with the use of external service suppliers. The principle is considered to be broadly observed, and potentials for improvement have been identified.

Internal and external operational risks are identified, and risks are managed through the use of systems, policies, procedures and controls.

Kronos2 has a high degree of security and operational reliability; among other things, Kronos2 runs on its own isolated IT platform which is duplicated at two operating centres, and tests have confirmed that Kronos2 has sufficient scalable capacity.

Danmarks Nationalbank follows up on compliance with agreed service level objectives by the service supplier through fixed service and risk reporting.

Formalised change management processes are in place. Change management is handled by the service supplier, but all changes are managed, prioritised and approved by Danmarks Nationalbank, while taking into account that changes are not implemented on critical days when there are typically many payments.

Danmarks Nationalbank has a business continuity plan with comprehensive measures to deal with situations involving a risk of operational disruptions. Business continuity plans and procedures are in place to ensure rapid recovery of operations and business functions, including the restoration of service within two hours and full payment settlement by the end of the day – even in case of critical disruptions.

Danmarks Nationalbank is part of the crisis management setup of the Financial Sector Forum for Operational Resilience, FSOR, which is to ensure effective and coordinated cross-sector action in the event of a critical operational disruption that could threaten financial stability, such as a large-scale cyber attack. Furthermore, since 2016, Danmarks Nationalbank

has been working with Finance Denmark, ES-CPH and e-nettet to identify and address risks across central systems in the infrastructure.

Potential for improvement of operational risk

A potential for improvement has been identified for operational risk management.

Supplier management can be strengthened by implementing a more systematic programme for controlling how critical service suppliers comply with Danmarks Nationalbank's Security and Risk Policy. Based on the decision to migrate the settlement of Danish kroner to the forthcoming European consolidated payment and securities settlement platform Target Services, beginning this work for Kronos2 is not deemed to be worthwhile.

Another potential for improvement concerns the involvement of participants in risk management efforts, including in the testing of Danmarks Nationalbank's emergency solutions. Danmarks Nationalbank is therefore expanding the testing of the bank's Extreme Contingency Facility, ECF,⁷ to include other payment systems and participants. In addition, Danmarks Nationalbank will increasingly involve participants in the risk management of Kronos2. This will be done at the regular meetings between Danmarks Nationalbank and the participants.

Danmarks Nationalbank is also working to further formalise which annual technical tests should be carried out.

Access

Principle 18 – Access and participation requirements;
broadly observed

Principle 19 – Tiered participation arrangements;
observed

⁷ ECF is the solution designed to ensure that the settlement of payments will continue in the event that Kronos2 is affected by a serious incident or failure at both operating centres.

Principles 18 and 19 relates to access requirements and indirect participation. A potential for improvement has been identified for Principle 18, while Kronos2 is considered to fully observe Principle 19.

There is a fair and open access to participation in Kronos2. Danmarks Nationalbank provides access to supervised credit institutions and investment firms and others which, within the framework of the Settlement Finality Directive⁸, are considered to be essential to payment settlement in Denmark. The requirements for participation are set out in Danmarks Nationalbank's terms and conditions for accounts, where the exit rules are also described.

It is possible to participate indirectly in the payment settlement in Kronos2. This is done by entering into an agreement with a direct participant that payments are executed through the direct participant's account. Indirect participation is primarily concentrated among the largest participants. Analyses of transaction data show that indirect participation is not a cause for concern in relation to payment settlement in Kronos2. Danmarks Nationalbank regularly reviews the risks associated with indirect participation.

Potential for improvement of requirements for access

As part of the implementation of the CPMI endpoint strategy, Danmarks Nationalbank has introduced the requirement that all Kronos2 participants connected through SWIFT must comply with the SWIFT Customer Security Programme's IT security requirements. Work is under way to impose similar requirements on non-SWIFT participants.

Efficiency

Principle 21 – Efficiency and effectiveness; **observed**
Principle 22 – Communication procedures and standards;
observed

Principle 21 relates to Kronos2's efficiency and effectiveness⁹, while Principle 22 is about communication standards. Kronos2 observes Principle 21 and Principle 22.

In order to ensure that Kronos2 is effective and meets its intended goals and objectives and the needs of the participants, Kronos2 has defined clear service level objectives which are described in a Service Level Agreement with the service supplier. Participants are involved in the ongoing development and operation of Kronos2 through user group meetings, where they can discuss their needs and wishes with Danmarks Nationalbank.

In order to ensure efficiency, Danmarks Nationalbank makes a point of ensuring fair and open access to participation in Kronos2. Among other things, this includes ensuring that the pricing structure is transparent and does not restrict the use of the system.

Kronos2 observes internationally accepted communication procedures and standards. The message format follows the ISO 15022 standard. Kronos2 also enables participants who use SWIFT and participants who do not to smoothly exchange messages and payments.

Transparency

Principle 23 – Disclosure of rules, key procedures, and market data; **observed**

Principle 23 concerns the disclosure of rules, key procedures and market data. Kronos2 observes Principle 23.

The rules and procedures for Kronos2, including emergency procedures, are set out in the terms and conditions for accounts for Kronos2, which are available – in both Danish and English – on Danmarks Nationalbank's website. The terms and conditions for

⁸ Article 2 of the Settlement Finality Directive lays down requirements as to who can be a participant in settlement finality-protected payment systems.

⁹ Efficiency refers to the resources required by the payment system to provide its services, while effectiveness refers to whether the payment system is meeting its intended goals and objectives.

accounts are supplemented by additional documentation about Kronos2 on the website, including pricing model, information about eligible securities for collateral and a system description.

All participants have received training in Kronos2 and have been provided with training material. If participants need further guidance, they can contact Danmarks Nationalbank's help desk during Kronos2's opening hours.

In July 2021, Danmarks Nationalbank published a detailed description of how Kronos2 observes PFMI which follows CPMI-IOSCO's disclosure framework. In addition, data relating to the use of Kronos2 has been made available on Danmarks Nationalbank's website.

PUBLICATIONS



NEWS

News offers quick and accessible insight into an Analysis, an Economic Memo, a Working Paper or a Report from Danmarks Nationalbank. News is published continuously.



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An Economic Memo is a cross between an Analysis and a Working Paper and often shows the ongoing study of the authors. The publication series is primarily aimed at professionals. Economic Memos are published continuously.



WORKING PAPER

Working Papers present research projects by economists in Danmarks Nationalbank and their associates. The series is primarily targeted at professionals and people with an interest in academia. Working Papers are published continuously.

The report consists of a Danish and an English version. In case of doubt regarding the correctness of the translation the Danish version is considered to be binding.

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