crunchfish

YEAR-END REPORT
2023

Focus on offline payments

Crunchfish's journey with offline payments started four years ago when we filed the first patent in January 2020. Crunchfish has explored many aspects of offline payments since then and has continuously expanded the product offering. There are reasons to believe that 2024 may be the commercial breakthrough year for us.

The initial patent application from 2020 is now a strong IP-portfolio with more than ten innovations related to offline payments. Over the years the ideas have become products. The first with both parties offline has been complemented with Digital Cash telecom where the payer can scan and pay offline anywhere. These products enable offline payments for online services. This is now expanded by providing better security for existing offline services. The initial focus was commercial payment services, and now public CBDC implementations are supported as well. We started marketing offline payments in India and have added partners and agents to reach the rest of the world outside India. We pioneer offline payments for smartphones but have showcased our solution on smartcards also. There are many offline payment combinations of patents & products, enabling online & offline services, for commercial & CBDC implementations, in India & worldwide, and smartphone & smartcard form factors, that can bring the commercial breakthrough we are aiming for.

Intention to divest our gesture business

The process of finding a new home for the exceptional gesture team has started. Crunchfish has engaged EY Corporate Finance to find a buyer. It is a tight and exceptionally talented organization that have successfully applied Machine Learning and AI to the area of computer vision and created a versatile XR-Skeleton platform for high-precision and high-performance gesture interaction. Gesture interaction is a "steel need" for AR/VR headsets and many providers opt to build it inhouse rather than sourcing it from a third party. The team will find a better position for further growth in an organizational setting closer to a target platform.

The divestiture is expected to lower the company's monthly operating expenses by approximately 25% when completed and will gradually allow the company to focus on offline payments and the development of the Digital Cash business, which have the strongest potential going forward. To clear the books for 2024 we have decided to write-off the gesture business as well as all IP in the Digital Cash business that is not related to offline payments. With the intended divestiture of the gesture business the focus of Crunchfish becomes clear. This opens up for potential strategic investments by industrial players into Crunchfish.

Offline payments for online services

Offline payment on smartphones reached the hands of end users in 2023. In the first half of the year Crunchfish proudly pioneered Digital Cash in a pilot with HDFC Bank and IDFC First Bank in the regulatory sandbox of the Reserve Bank of India (RBI). The pilot was successful, and RBI gave its blessing in December that Crunchfish Digital Cash may be implemented by their regulated entities, which means Indian banks and digital wallets. This milestone opens opportunities for Digital Cash in 2024. As a direct result of the pilot IDFC First Bank became the first customer of Crunchfish Digital Cash in June. An initial offline payment solution has been developed for the Digital Rupee pilot by IDFC First Bank. Crunchfish and IDFC First Bank presented the ready solution for RBI in October and was awarded runner-up in their Harbinger Hackathon. This Digital Cash telecom solution will bring revenue in 2024.

Offline protection for offline services

Discussions with HDFC Bank are ongoing although they have not signed a contract yet for multiple reasons. The launch of UPI Lite X by National Payment Corporation of India (NPCI) as an offline payment wallet at the Global Fintech Fest in September was certainly one. It is an offline wallet for banks and payment applications in the UPI payment ecosystem and it is a very important milestone that UPI includes support for offline payment. Crunchfish recently launched the Digital Cash protector to increase the security levels in such 3rd party offline payment services. It has great business potential in 2024 as it may be offered to multiple hierarchical levels in the payment ecosystem.

Major central banks focus on offline payments

2024 started with a surprise when the European Central Bank (ECB) in early January called for applications for a digital euro pilot. Offline payment is one of five areas and ECB requests tender for an offline solution on smartphones and smartcards that should be integrated and operated as an add-on service to the underlying Digital Euro online system in a pilot for four years. Noteworthy is that they are requesting to purchase the source code and full rights to the offline solution for use with the Digital Euro as ECB does not want to take the risk if the offline solution provider is not able or willing to continue to support the offline solution. ECB therefore budget 220 million EUR, which may be extended to 660 million EUR for the offline service.

Last week the Reserve Bank of India announced that their ongoing CBDC Retail (CBDC-R) pilot that currently enables Person to Person (P2P) and Person to Merchant (P2M) online transactions using Digital Rupee wallets provided by pilot banks. RBI proposes now to introduce an offline functionality in CBDC-R for enabling transactions in areas with poor or limited internet connectivity. Both proximity and non-proximity based offline solutions will be tested. These functionalities will be introduced through the pilots in a gradual manner. Crunchfish has a pilot which ready to go with IDFC First Bank demonstrating a non-proximity based offline solution. Also, the new Digital Cash protector was also well received by RBI as it will provide better offline security for proximity-based transactions. Crunchfish is very well connected with many key stakeholders. I am confident that Crunchfish will play an important role in India for the Digital Rupee during 2024.

Offline payments purchased centrally

The request to purchase source code rather than licensing binary code is common for national schemes where the offline solution is implemented by multiple banks and in multiple payment services. CBDC implementations are often of this nature as well as open instant payment schemes such as UPI in India and PIX in Brazil. The agreements become very large central deals for the whole payment ecosystem, rather than separate license agreements by each payment application. The same business logic applies to the new Digital Cash protector. It could either be licensed with source code and centrally integrated for all payment applications in the ecosystem or licensed as binaries individually by each payment application. The target is to sign a central agreement for a national scheme in 2024. This could outperform all forecasts for the coming year.

Significant news during and after Q4

Crunchfish group

2024-02-02

Crunchfish together with its Board of Directors have undertaken a strategic review of the business, resulting in a decision **to explore a divestment of the Crunchfish Gesture Interaction** subsidiary.

2023-11-02

The board of directors of Crunchfish **announced the outcome of the rights issue** that was announced on September 20th, 2023.

2023-10-16

Crunchfish prepared an **EU Growth Prospectus** regarding the rights issue of units announced on September 20th, 2023. The Prospectus was approved and registered by the Swedish Financial Supervisory Authority.

Digital Cash

2024-02-13

Crunchfish **announced the Digital Cash protector** as an offline payment application protection add-on for 3rd party offline payment services.

2024-02-12

Crunchfish Digital Cash **entered a partnership with SaaS Expand** to target mobile operators in Africa.

2024-02-01

Crunchfish **released a new white paper** as an independent continuation to the series "Enabling offline payments in an online world", with the tittle "Offline payments for smartphones."

2023-12-12

Reserve Bank of India **approved Crunchfish Digital Cash for Offline Retail Payments**, after concluding the pilot that Crunchfish participated in together with HDFC Bank and IDFC First Bank.

2023-11-17

Crunchfish and IDFC First Bank **discussed offline payments** in FNA's CBDC Broadcast – The next frontier of payments.

2023-11-16

Lipis Advisors in partnership with Crunchfish **released the sixth and final white paper** in the series "Enabling offline payments in an online world" with the title "Ensuring trust in scalable offline solutions ".

2023-10-30

Crunchfish completed an **integration of Digital Cash with the Mojaloop payment platform**. Financial service providers will now be able to offer its users the ability to perform payments with Mojaloop even when offline.

2023-10-24

Crunchfish Group CEO Joachim Samuelsson **presented Crunchfish's pioneering Digital Cash solution at Aktieportföljen Live**. The focus was on Crunchfish's unique ability to deliver secure and scalable offline payments for digital wallets and CBDC implementations in India and other parts of the world.

2023-10-12

Crunchfish in collaboration with IDFC FIRST Bank **were announced runner-up** for its Digital Cash telecom solution, in Reserve Bank of India's second global hackathon HaRBInger 2023 on the theme "Inclusive Digital Services".

Gesture Interaction

2024-01-10

Crunchfish Gesture Interaction and LogistiVIEW Inc. **extended the license agreement** and collaboration to continue delivering gesture-based logistics solutions.
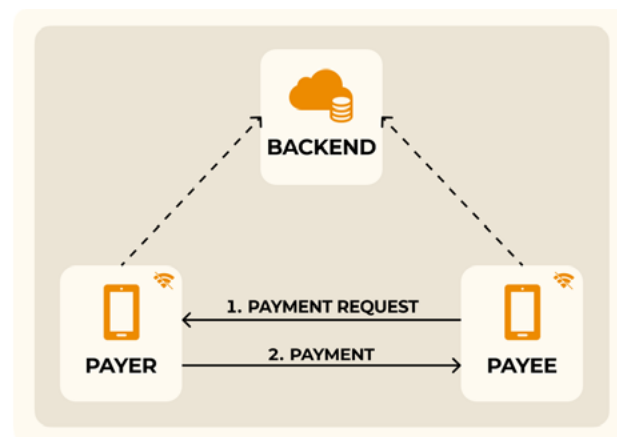
2023-10-27

Crunchfish announced the **release of version 2.4 of XR Skeleton SDK**. The latest version based on the XR Skeleton Platform is packed with improvements to help customers and partners create successful XR experiences.
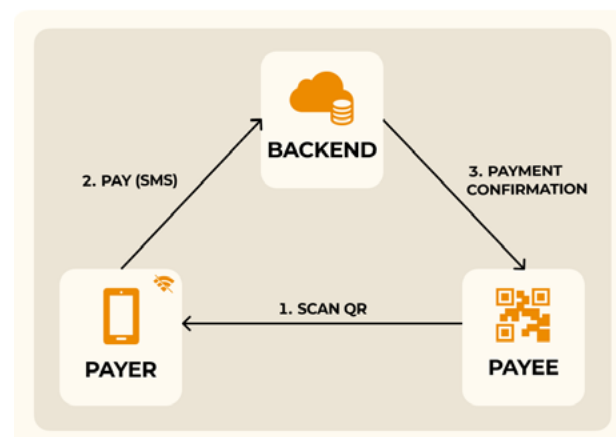
Digital Cash
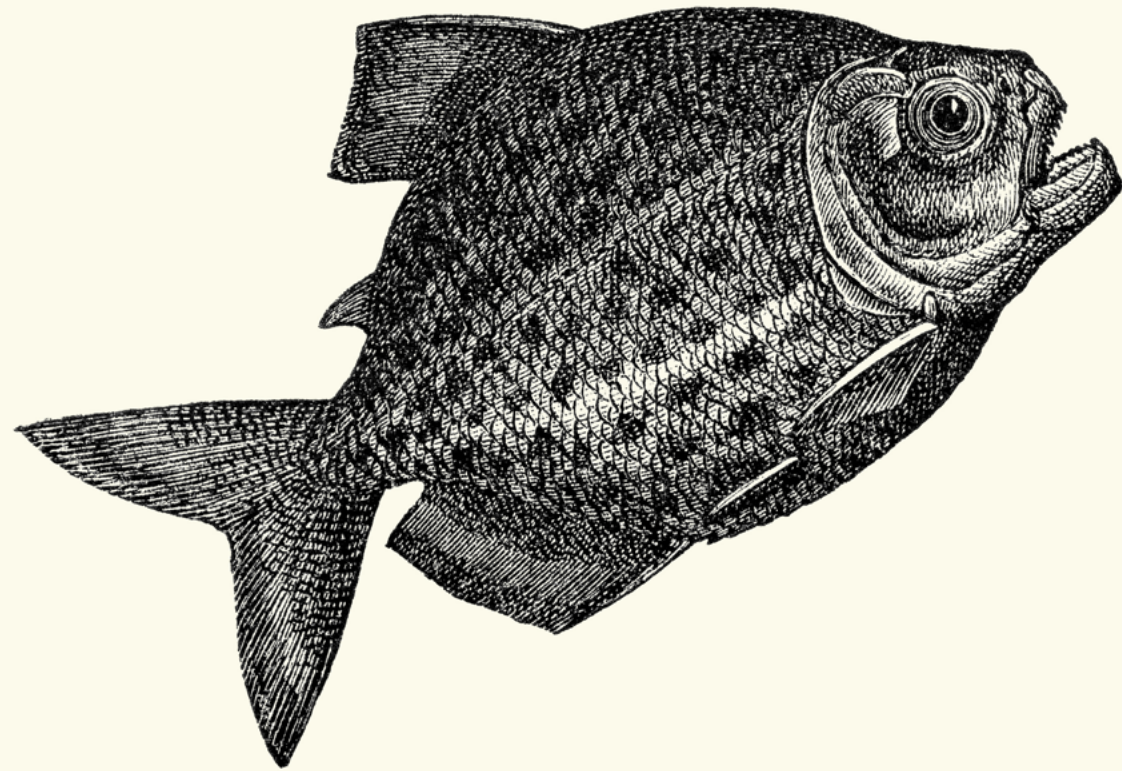
Digital Cash for the Indian market

India is the leading instant payment market in the world with almost half of world's transaction volume. The Reserve Bank of India (RBI) and the National Payment Corporation of India (NPCI) are the backbone of this remarkable dominance. Crunchfish has defined its Digital Cash products for the needs in India. If Digital Cash can be successfully deployed in India, it can be rolled-out anywhere in the world.

India's payment ecosystem is dominated by UPI. The world's most successful instant payment scheme. UPI was launched in India in November 2016 and currently has a transaction volume well over 10 billion transaction per month. NPCI who is behind announced at the Global Fintech fest in Mumbai plans for a 10x increase over the next five years to 100 billion transactions per month. To get there it is important to leverage offline payments for load balancing for banks, payment resilience in congested hotspots, and better coverage in geographic zones where internet connectivity is sparse or non-existent.
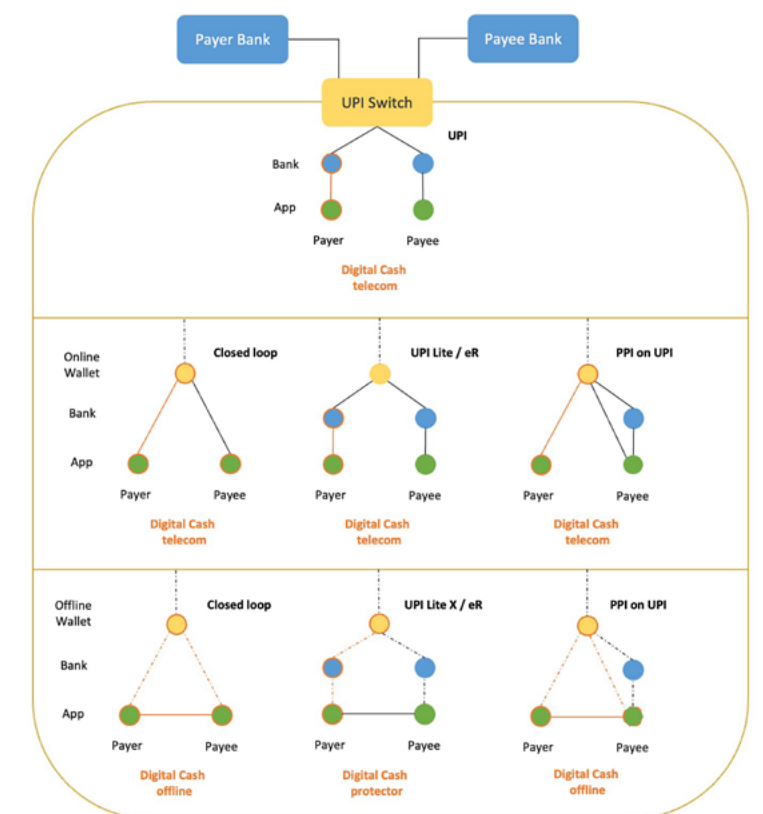
RBI is piloting CBDC with leading banks. In February 2024 RBI announced that offline payments in proximity as well as non-proximity is a priority for their Digital Rupee implementation. It is NPCI that implements and operates the eRupee (eR) solution for RBI by leveraging their UPI payment rail. In addition to UPI and eR there are many eWallets in India which are referred to as prepaid instruments (PPI). They may either be closed-loop systems or interoperable with UPI, called PPI on UPI.

Offline payments in proximity allow users to conduct transactions without a real-time connection to a central server, offering reliable payments at the time of payment regardless of the state of the payment service backend.

- **Digital Cash offline** approved by RBI for regulated entities in December 2023. Adds *offline* payment in proximity to online payment services.

- **Digital Cash protector** is a new offering that adds *offline* payment application protection for offline payment services in proximity.

Offline payment in non-proximity enables scan and pay, without data connectivity by leveraging the telecom network. Send a secure signed payment in a single SMS to anyone onboarded in the payment service.

- **Digitial Cash telecom** awarded runner-up by RBI in Harbinger hackathon in October 2023. Adds offline payment in non-proximity to *online* payment services.

A mapping of how Crunchfish Digital Cash products enable offline payment / increased offline payment security in India.

- **Digital Cash telecom**
  o Enables offline payment in non-proximity for UPI, UPI Lite, eR, closed-loop, and PPI on UPI online wallets.
- **Digital Cash offline**
  o Enables offline payment in proximity for closed-loop and PPI on UPI online wallets.
- **Digital Cash protector**
  o Increases offline payment security for UPI Lite X and eR offline wallets.

Digital Cash Market

The market for offline payments is at an early stage. Historically digital payment services only functioned online, now offline payment is starting to come into focus for various reasons. Crunchfish sees that the trend towards offline payment is mainly driven from India and from the world's central banks as cash is digitized, aka Central Bank Digital Currency (CBDC).
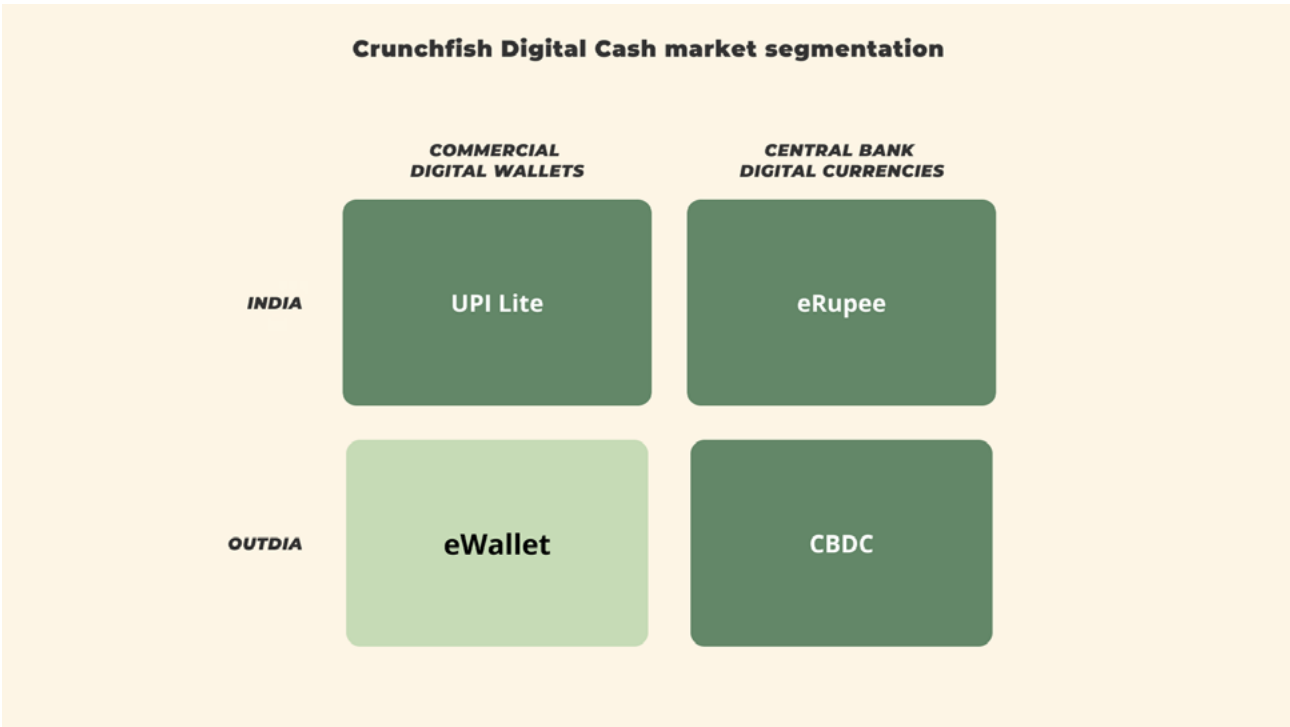

Offline payment makes the payment services more robust because they work even if a payer temporarily lacks internet connection or if any backend server is overloaded or down. Offline payment increases financial inclusion as mobile payments can be made in areas without internet. The payment services can also be made more scalable because offline payments can take place without burdening the central payment system at the time of payment. There are also increased opportunities to be private because the payment can be made by debiting the payer and crediting the recipient's balance, without the transaction itself being registered centrally.

India is the leading market in the world for real-time payments. United Payments Interface (UPI) is India's real-time mobile payments platform, developed by the National Payments Corporation of India (NPCI) and regulated by the Reserve Bank of India (RBI). UPI enables transactions between banks through mobile payment applications. It connects different bank accounts through a common platform, making it possible to transfer money in real time. Crunchfish sees that UPI needs to become more robust because the internet connection in the country has shortcomings but also because the banks' systems can become overloaded by the large transaction volume in the country. RBI is pushing towards offline payment and has allowed offline payment for smaller amounts. Offline payment is seen as an opportunity for increased robustness and scalability and NPCI has recently also launched UPI Lite

X for offline payment where neither payer nor recipient has any connection. Accordingly, offline payments will be widely used in India for UPI, digital wallets as well as the digital rupee once the RBI digitizes the cash.

Outside India, offline payments have not developed as much. Here, it is mainly providers of digital wallets in countries with poorer internet connections who strive to be able to offer their customers more robust payments, e.g. in Africa. Above this, it is the central banks that drive the trend towards offline payment when they digitize cash. Few countries have launched a CBDC yet, but most are investigating and are in pilot phases.

Crunchfish Digital Cash market segmentation

	COMMERCIAL DIGITAL WALLETS	CENTRAL BANK DIGITAL CURRENCIES
INDIA	UPI Lite	eRupee
OUTDIA	eWallet	CBDC

Approved by Reserve Bank of India

During Q4 the Reserve Bank of India concluded the Offline Retail Payments pilot that Crunchfish participated in together with HDFC Bank and IDFC First Bank. The project was very successful, and the solution is now approved for adoption by regulated entities.

Crunchfish in partnership with **HDFC Bank** and **IDFC First Bank** during Q2 2023 completed a joint project in the Reserve Bank of India (RBI) Regulatory Sandbox to demonstrate and pilot Offline Retail Payments. The pilot has been thoroughly evaluated and concluded by RBI. In an **official statement from RBI** dated December 11th, they stated that the offline solution may be considered for adoption by regulated entities subject to compliance with applicable regulatory requirements. This is an important statement from RBI, as it further strengthens Crunchfish Digital Cash as being highly relevant for the Indian market. It also supports efforts with banks and payment services in India, as well as the dialogue with NPCI regarding UPI Lite X.

NPCI launched UPI Lite X during the fintech fair GFF in September 2023 to facilitate offline payments. Crunchfish welcomes NPCI's focus on offline payments and believes that Digital Cash complements UPI Lite X with a more secure and versatile offline payment solution for the Indian payment ecosystem. Like Crunchfish Digital Cash, UPI Lite X is based on that the payer and the recipient can trust each other and the offline payment, in a similar way that a card terminal can trust a credit card. Crunchfish Digital Cash has applied for a patent for the solution and has also received positive international reports on patentability that protect how each party can forward the offline payment to the payment system's backend in a secure manner, to increase the reliability of the payment system. UPI Lite X uses the same approach and Crunchfish has brought this to NPCI's attention, even though Crunchfish has no granted patents yet in India as they are pending examination. An NDA has been entered with NPCI to explore how Crunchfish Digital Cash can complement and improve UPI Lite X. Based on these discussions and recommendations from NPCI, Crunchfish have a designed a solution that will be demonstrated to NPCI together with one or a few selected banks.

Crunchfish in collaboration with IDFC FIRST Bank were announced **runner-up for its Digital Cash telecom solution** in Reserve Bank of India's second global hackathon HaRBInger 2023. Crunchfish solution competed in the problem statement "New use cases for CBDC-Retail including offline transactions". It allows the user to scan & pay by initiating payments, without internet connectivity, with an SMS to the payment service. The solution was showcased at the HaRBInger Grand Finale October 11th by Crunchfish and representatives of IDFC FIRST Bank that demonstrated their ready implementation in the **IDFC FIRST Bank Digital Rupee** app. The Digital Cash functionality will be made available in the app as an upgrade through Google Play and Apple App Store. The app has after the HaRBInger award also passed review by RBI and is only pending formal approval from RBI management before a first batch of app users will be onboarded, which is expected to happen during Q2.

Discussions regarding a license agreement for Digital Cash with HDFC Bank is still ongoing. HDFC Bank is yet to decide whether to implement offline functionality in its payment applications with Crunchfish Digital Cash and/or UPI Lite X.

Sunil Karkera, Senior Product Manager, Payments and Fintech Partnership at IDFC FIRST Bank. Nayan Mehta Product Manager, Payments and Fintech Partnership at IDFC FIRST Bank. Gagan Kochar, Head of Business Development India at Crunchfish.

CBDC starting to bloom

Crunchfish mainly works through partners in the CBDC eco-system but also have direct relations with central banks and continuously publishes whitepapers to position offline payments. Clear signs in market tells that offline support will be a key requirement for CBDC deployments around the world.

A majority of the world's central banks are evaluating or preparing to roll out CBDC. Support for offline payments is on the agenda for most of these projects. Late Q4 and early Q1 tenders came out from three central banks in different parts of the world stating this, as all of them have offline support as key requirements. European Central Bank has issued calls for applications to establish framework agreements for pilots in five focus areas around the digital euro, whereof offline support is one. The offline call by itself is budgeted by ECB at an estimated value of 220,7M EUR, and a maximum value of the framework agreement at 662,1M EUR. Further to this a central bank in the Middle East has issued an RFP for a CBDC pilot with offline payment as part of the requirements for the pilot. The third example is a central bank in the Caribbean who is searching for information around offline payment support as part of an RFI.

Crunchfish's go-to-market strategy for the CBDC market is to partner with CBDC platform vendors and other relevant companies in the CBDC eco-system. The platform vendors integrate Digital Cash into their solution to be able to offer offline payment to central banks. With one of the partners, a joint proposal has been submitted to the RFP for a CBDC pilot for the central bank in the middle east. IDFC FIRST Bank is an important partner for Crunchfish to address the Digital Rupee, India's CBDC initiative. Currently only banking apps are allowed to carry the Digital Rupee which makes the partnership key to position Digital Cash in this arena.

Crunchfish has positioned Digital Cash against central banks and the surrounding ecosystem of suppliers by attending and presenting at CBDC conferences around the world and hosting the white paper and webinar series "Enabling offline payments in an online world". During Q4 the sixth whitepaper in the series was released – "Ensuring trust in scalable offline solutions". The paper wraps up the first six papers and includes an editorial on secure and scalable offline payments for smartphones. During Q1 a separate whitepaper about Offline payments for smartphones was also released, which outlines the challenges to implement offline payments on smartphones and how to mitigate the risks.

Targeting mobile operators in Africa

Crunchfish's sales efforts have mainly been aimed towards India and the CBDC community. In Africa, mobile payments have become an integral part of the economy, but the lack of sufficient infrastructure and internet connectivity is a limiting factor. With offline payment support, the power of mobile payments in Africa can reach its full potential. A partnership has been entered with SaaS Expand Agency to develop opportunities that this brings for Crunchfish Digital Cash.

Mobile payments have become an integral part of the African economy, with many businesses and individuals relying on it for day-to-day transactions. Mainly provided by telecom operators and supported by a network of licensed agents, mobile money services allow registered users to deposit cash into a digital wallet, and use those funds for payments and purchases, including peer-to-peer (P2P) payments. However, the lack of sufficient infrastructure and internet connectivity limits the potential and the use of these payment services. With Digital Cash and offline support, the power of mobile payments in Africa can reach its full potential.

To develop the opportunities in Africa a partnership agreement has been entered with SaaS Expand Agency. The founders of SaaS Expand Agency bring long experience from dealing with telecom operators in Africa. The company is set up to act as an agent for Crunchfish. Initial focus will be on the large telecom operators in Africa. Already a first NDA has been entered with a major operator group that is present across Africa. The partnership between Crunchfish and SaaS Expand Agency also covers the rights for SaaS Expand Agency to act as an agent in South America. Opportunities in South America will be explored in a later phase, as Africa is the initial focus.

"At SaaS Expand, our mission is fueled by the transformative potential of technology in connecting cultures and enhancing personal safety and wellbeing. The integration of offline payments through Crunchfish Digital Cash is set to revolutionize financial accessibility in Africa and South America. This innovation promises to bring secure, inclusive financial services to even the most remote areas, significantly impacting the daily lives and empowerment of millions," **says Frederik Weisz, SaaS Expand's Managing Director.**

Offline payments for smartphones

In the dynamic landscape of mobile payments, offline payments for smartphones have gained traction[1]. Offline payments allow users to conduct transactions without a real-time connection to a central server, offering convenience but also introducing unique challenges in terms of security and reliability.

Offline payment refers to the ability of a smartphone to complete transactions without requiring a continuous internet connection. This feature enhances user convenience, especially when network connectivity is intermittent or unavailable. Another benefit of offline payments is their ability to constantly work at the time of payment regardless of the state of the payment service backend. Hence, offline payments can alleviate pressure on the core banking system for low-value transactions.

Adding offline payment capabilities to a payment application requires handling a local offline balance, representing the funds available offline. But that is not all; there is also a need to add several other important asset types described in the graphic referred to as the offline assets. The payment application ensures that the offline assets are kept secure both during execution of the application, which we refer to as securing the application runtime, but also at rest, where these assets are stored.
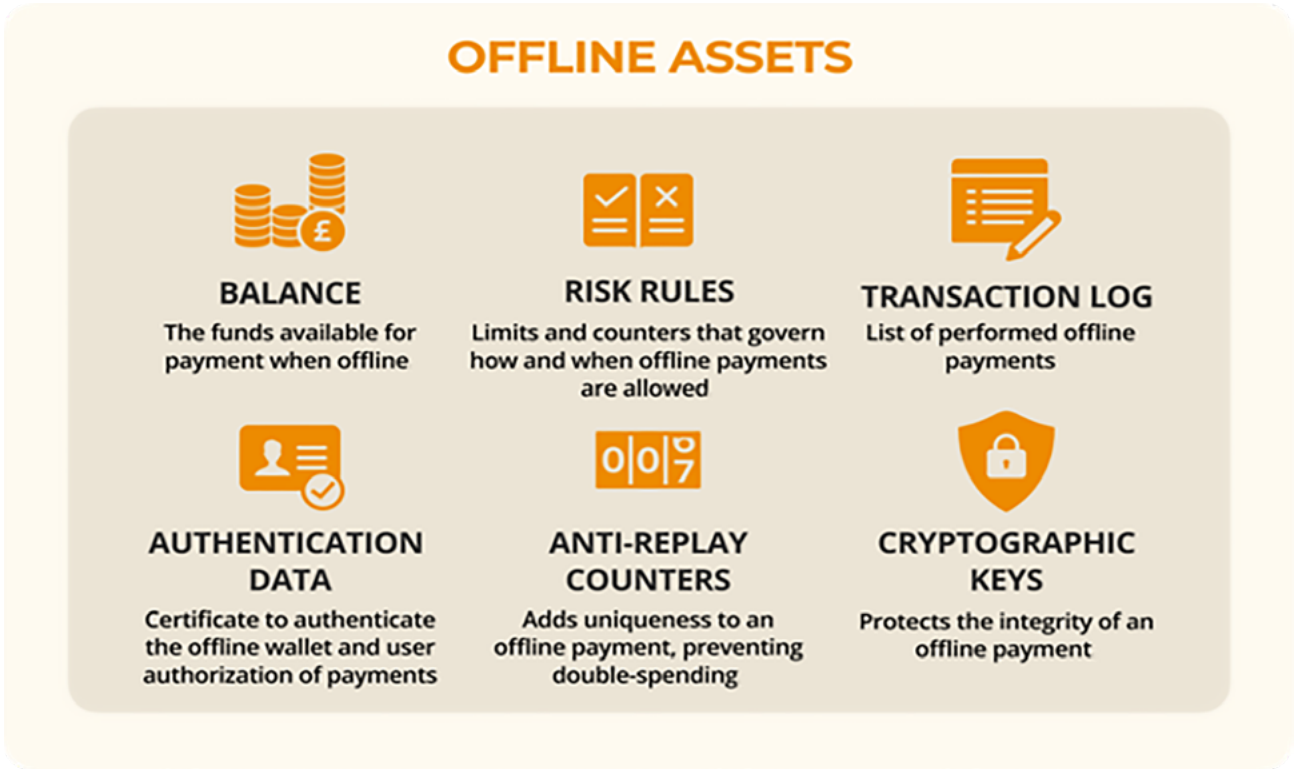
Mobile application protection is hard, and existing mobile software protections are insufficient for offline payments. They come in different shapes and forms, but all use three types of software protection: Code Obfuscation, Runtime Application Self-Protection (RASP) or App Shielding, and White-box Cryptography. Fundamentally, all these protections are better than nothing but do not suffice for offline payments since they do not hold attackers back for long[2]. A payment application requires protection not only against direct attacks on the application itself but also against indirect attacks that may manifest as manipulation of the OS or exploitation of hardware vulnerabilities.

While performing an offline payment, the application executes code that operates on the offline assets. This is a sensitive operation that requires specific protection. Using standard Android or iOS security for offline payments is not sufficient since the security available is not designed for that purpose. For example, the Android Keystore or iOS Keychain provides an isolated runtime where applications can generate keys and perform cryptographic operations. However, it protects only the use of cryptographic keys and is, therefore, not sufficiently secure for offline payments as they lack a secure runtime for other offline assets. A simple attack is all it takes to bypass the offline balance and the risk limits. Furthermore, it has been proven that Android Keystore, built on top of ARM Trustzone, has vulnerabilities that have given an attacker access to the private keys stored within[3].

OFFLINE ASSETS

BALANCE
The funds available for payment when offline

RISK RULES
Limits and counters that govern how and when offline payments are allowed

TRANSACTION LOG
List of performed offline payments

AUTHENTICATION DATA
Certificate to authenticate the offline wallet and user authorization of payments

ANTI-REPLAY COUNTERS
Adds uniqueness to an offline payment, preventing double-spending

CRYPTOGRAPHIC KEYS
Protects the integrity of an offline payment

A payment application must handle new asset types when enabling offline payment capabilities.

Crunchfish Digital Cash provides a secure environment for offline payments. It is an integral part of the payment application, shielding it from the OS and hardware provides a consistent level of security for offline payments independent of the device. It is highly scalable, as Digital Cash is deployed and updated with the payment application on all smartphones using app stores. It offers a secure, isolated runtime by a virtual machine and encrypted storage with rollback protection for all offline assets. Digital Cash can securely run on rooted or jailbroken devices, as a compromised device does not affect the running of Digital Cash. The following two sections are an attempt to explain what this means in terms of delivering an offline payment solution that is both secure and scalable.

1. *https://www.bis.org/publ/othp64.pdf*

2. *https://eprint.iacr.org/2018/098.pdf*
3. *https://ieeexplore.ieee.org/document/9152801*

The Risks with Offline Payments

Offline payments introduce specific risks that need careful consideration. The immediate risk is the ability to double-spend the balance while being offline. Since the offline assets reside in a device that is in the control of an attacker, it is paramount that the payment application takes the necessary precautions to protect the offline assets and any operation performed on them. There are multiple ways that a potential attacker can take to perform an attack that results in double-spending.

Payment applications running on smartphones are implemented in the software-based Rich Execution Environments (REEs), which provide high levels of programmability but are not secure enough for offline payment operations. Cryptographic keys and other offline assets such as the offline balance and risk limits are not safe from simple attacks.
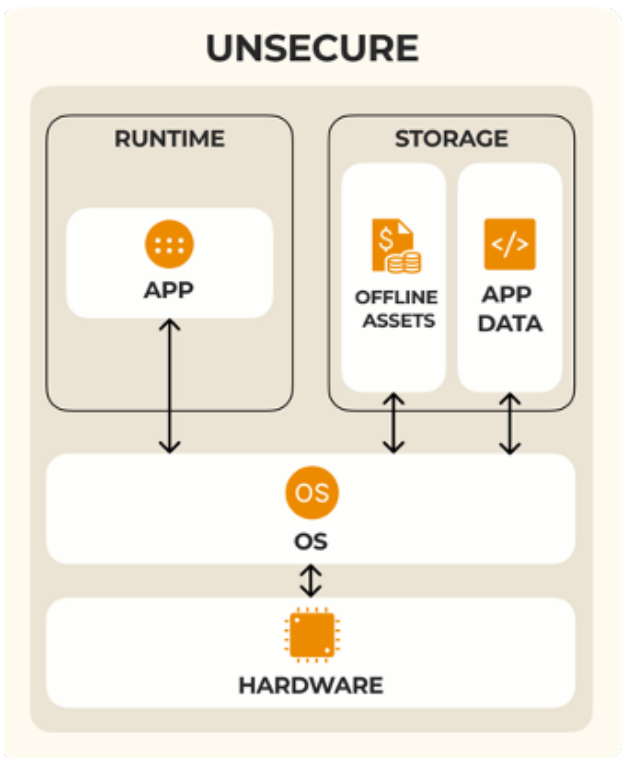
An unsecure offline payment solution implemented in the Rich Execution Environment without adequate security mechanisms in place.
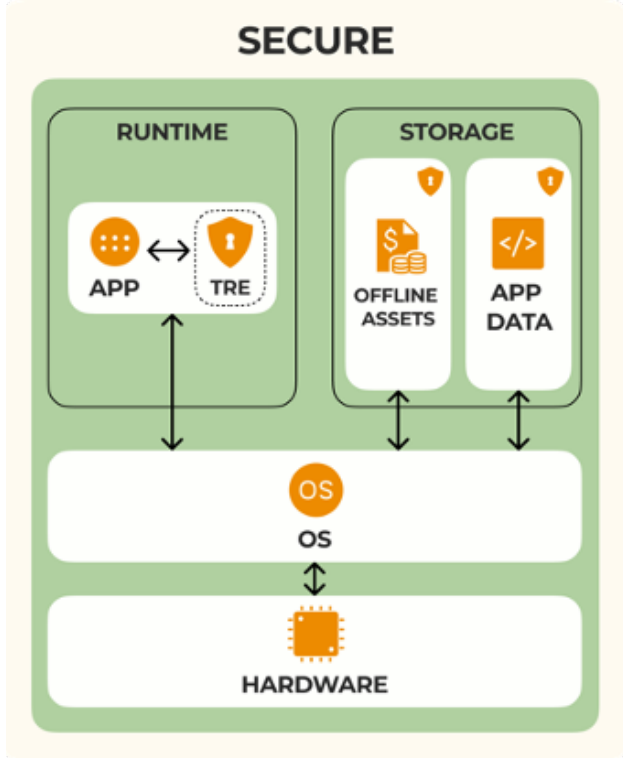
A secure Offline Payment solution implemented in a software-based, app-integrated virtual TRE that protects the application runtime, the application data, and all offline assets.

Attacking the Bearer Instrument

Rooting (Android) or jailbreaking (iOS) a device is probably the first cause of action when attempting to attack an offline payment solution due to its simplicity and availability[1]. When users root an Android device or jailbreak an iOS device, they gain elevated privileges and access to parts of the operating system that are typically restricted. This allows users to customize their devices extensively, install unauthorized applications, and modify system files such as the offline assets and application data. One way to approach this issue is not to enable the payment application to run if a device is rooted or jailbroken using root-detection software. However, root detection is like a cat-and-mouse game between the users and manufacturers. Hence, root-detection is always one step behind, and counting on these measures is risky. Often, they are easily circumvented by new rooting software. When designing a solution for offline payments, it is crucial to consider that rooted or jailbroken devices are present in the system.

Attackers can exploit rooting software to gain unauthorized access to application data and encryption keys. Additionally, manipulating the operating system can deceive applications by feeding them faulty information. Furthermore, altering the device's time can alter the application's behavior. All these attacks can lead to a successful double-spending attempt. It is also possible to exploit vulnerabilities in hardware, such as the CPU, which has been proven to leak cryptographic keys[23]. Using the security features of the mobile operating system (OS) leaves the app blindly trusting whatever the OS throws at it. This is significant because changing the OS is relatively easy, and applications rely on sensitive APIs and cryptographic operations.

Attacking the Application Runtime

While performing an offline payment, the application reads the offline assets into memory, performs cryptographic operations, creates a transaction, and modifies the offline assets. Here, an attacker can attempt to alter the code paths to circumvent risk rules, read the sensitive data from memory, and even inject code to bypass security checks and alter values to create a valid offline payment outside the limits of the offline assets. Common ways to attack the application are various forms of tampering, using hooking software to alter and inject code into an application and decompiling or reverse-engineering the application data. It is essential to embrace the likelihood that the security mechanisms can be circumvented and ask how that would affect the system.

Attacking the Stored Offline Assets

An attack on the offline assets typically means attempting to tamper, copy, or restore the data. If such an attempt is successful, the attacker can, e.g., extract cryptographic keys, increase the offline balance, modify the risk rules, and remove transactions, making it possible to spend money that has already been spent. These attacks can generally be performed by, e.g., copying an application to another device, running multiple instances of the same application, or restoring the state of an older version.

1. https://www.kaspersky.com/blog/android-root-faq/17135/
2. https://www.usenix.org/system/files/conference/usenixsecurity17/sec17-tang.pdf
3. https://theses.hal.science/tel-03282313/file/TROUCHKINE_2021_archivage.pdf

Mitigating the risks with Offline Payment

Ensuring trust in offline payments circles around protecting offline assets in various situations. It is possible to attack these offline assets in different ways. Hence, an offline payments solution needs multiple layers of security mechanisms to counter-act, detect, and mitigate these attacks. This section covers the minimum baseline of security mechanisms required to achieve enough trust to conduct offline payments safely.

KEY REQUIREMENTS FOR OFFLINE PAYMENTS

The inevitable presence of rooted or jailbroken devices must be handled.

TRE
Implemented in a tamper-resistant element with an isolated runtime.

Rollback protection is a must-have to protect stored offline assets.
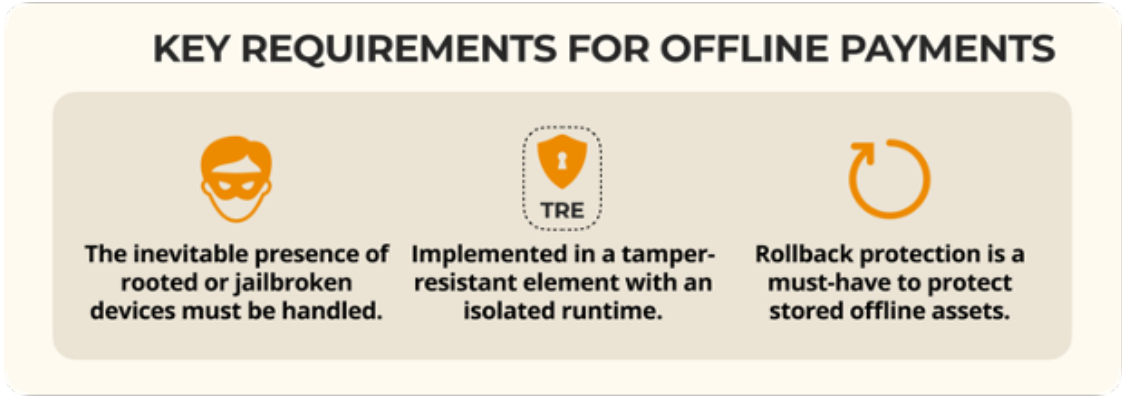
The key requirements for Offline Payments.

Protecting the Application Runtime

A tamper-resistant element (TRE) is a security feature designed to prevent or detect unauthorized access, modification, or compromise of a device. This TRE can provide an isolated secure runtime, which is very difficult to attack from the outside. Here, it is safe to perform operations on all offline assets and generate, store, and operate on cryptographic keys without risking any interference from a potential attacker. A secure, isolated environment is essential for an offline payment solution to ensure its logic remains secure.

One way of achieving this isolation is to integrate a software-based, app-integrated virtual TRE in the payment application. Using the foundation of a virtual TRE, multiple layers of protection can run through its secure, isolated runtime, securing the protection mechanisms themselves[1]. Attackers cannot tamper with the payment application or bypass the protection mechanisms without first breaking

the TRE itself. Combining multiple protection mechanisms is crucial for achieving the necessary security for the payment application. Examples of protection mechanisms to consider are (but are not limited to) anti-reverse engineering, time locking, anti-cloning, anti-code-lifting, anti-debugging, anti-hooking, anti-code injection, app integrity checks, and emulator/simulator detection. Detecting a threat locks the payment application and requires the backend to unlock it again.

The virtual TRE, using a virtualized CPU and encrypted memory, creates a self-contained space within the application, isolating it from the underlying OS. This isolation ensures that the offline payment solution operates within its secure environment, shielded from potential vulnerabilities or changes in the OS. The virtual TRE includes many necessary dependencies and libraries for offline payments. This independence means offline payments are less reliant on external OS components, reducing the risk

of vulnerabilities associated with OS updates. Keeping the app self-sufficient makes security updates as simple as updating the payment application. This is key to ensuring scalability in the market, as offline payments are available to all smartphones without any dependencies on devices or mobile operators. Furthermore, the application-bound architecture allows a payment application to run securely on rooted devices, which makes the question of rooted vs non-rooted irrelevant. Root detection mechanisms may still complement an offline solution but should not depend on it. Hardware-based standalone TREs are another type of TREs that can provide an isolated runtime and secure storage for offline payments. Smartcards use standalone TREs but they may also be implemented on a mobile device either as an embedded SE or on a SIM or eSIM. A common belief is that hardware-based TREs are always more secure than software-based virtual TREs because of the clarity of security boundaries. However, due to the inevitable separation between the payment app and the hardware-based TRE, there a gap in the chain of trust between the two communicating endpoints. This can result in potential attacks by replacing either endpoint with malicious ones or tampering with them and modifying their behavior during runtime. As the standalone TRE does not have full visibility of the payment app and the mobile OS, it cannot determine the identity of the app or whether the app has been tampered with and must "blindly" trust the OS and the app[2].

The main difference between implementing offline payment on a standalone TRE vs. a virtual TRE is not related to security but to scalability. Provisioning offline payment on a standalone TRE in a mobile device poses significant challenges. To achieve widespread market availability for a payment application with offline payment support, there is a need for the payment application provider to partner with a sufficiently large number of device manufacturers or possibly mobile operators to provision a standalone TRE with an offline payment applet on smartphones. There are also additional costs and challenges in manufacturing and distributing the standalone TREs to smartphones. This creates hurdles to bringing mobile payment applications with offline payment on standalone TREs to market. Whereas hardware-based standalone TREs are costly and hard to deploy due to device fragmentation, this is not the case for software-based app-integrated virtual TREs. On the contrary,

it is a cost-efficient solution that is easy to integrate with the payment applications and deploy and update on app stores for any smartphone.

Protecting the Stored Offline Assets

Securing the payment application is crucial, but we must also protect the offline assets stored on the device. Android Keystore and iOS Keychain store their cryptographic keys encrypted on the device's filesystem. This protects the key itself from being copied to another device, but it does not protect it from attacks happening on the same device.

Instead, storing the offline assets in trusted storage through the virtual TRE is a great way to keep the offline assets in the control of the application while also keeping them encrypted using cryptographic keys. This restricts access to the offline assets, but they are still stored on the file system, leaving them open to attack.

Rollback Protection

Implementing rollback protection is a must-have to prevent tampering with the offline assets stored on the device. A rollback attack, in short, is a way to restore a previous state, usually a balance, of a wallet, making it possible to spend money that has already been spent. This type of attack opens the possibility of double-spending. To counter a rollback, an offline payment solution requires the detection of any tampering with the offline assets and, as a result, locking the offline wallet. Additionally, utilizing a TRE also protects the rollback protection logic from tampering. Unlocking the offline wallet is only possible through an online sync with the backend.

Leveraging Backend Reconciliation

There is increased acknowledgment from the market that backend reconciliation is an important mechanism when securing offline payments. The ECB has indicated that user devices would be expected to go online regularly for offline payments using a future digital euro[3]. By leveraging the backend, the offline payment solution can perform synchronization operations between the offline wallet and the online backend. For example, the online backend can analyze offline transactions and detect if a particular user made a rollback of the offline assets and, if so, enforce a lock of the user's offline wallet.

1. https://www.crunchfish.com/wp-content/uploads/2023/11/Lipis_WP6_Crunchfish_Enabling-offline-payments.pdf

2. https://www.v-key.com/resource/most-mobile-authentication-apps-can-be-breached-even-if-hardware-security-is-used/

3. https://www.ecb.europa.eu/paym/digital_euro/investigation/profuse/shared/files/dedocs/ecb.dedocs230113_Annex_1_Digital_euro_market_research.en.pdf

Gesture Interaction

Big strides for mixed reality

An eventful 2023 brings positive momentum and opportunities ahead.

The past year has been nothing less than a huge breakthrough year within XR. At its foundation the driving factor has been all advancements within AI and the widespread use of services like ChatGPT, Bard etc. and the year has truly been a shift towards a world where humans interact closely with machines. Now it is possible to have a digital personal assistant with the IQ of Albert Einstein. A great super-power that has become accessible to a large part of the population.

This change has become a catalyst for engineers across the globe to challenge many tasks today done by a human and explore if it can be carried out by a machine instead with as good as, or even better, outcome than today.

The overlap of the Venn diagram between generative AI and machine learning or computer vision is clear. For machines to become more autonomous and be able to make better

decisions they need context in the form of data. The data can be injected or it can be read by the machine itself if it can see the world using computer vision. The technology developed at Crunchfish Gesture Interaction is in the computer vision field. The team has long tenure and experience in this area both theoretically and applied when developing hand-tracking and gesture interaction for AR and VR devices.

Along with all the strong advancements within AI the year has from a macro perspective been very challenging, especially to smaller companies. Many projects have been delayed or canceled and many companies have been forced to reduce workforce or even close up shop. Despite the difficult times there have been strong announcements with Apple being at the forefront with their mixed reality (MR) device, Apple Vision Pro, where the user can shift from a fully immersed experience to see-through. Since the

announcement, competition has made plans and are fully engaged in bringing alternatives to the market. Notable recent investments in the industry are Magic Leap's $590M funding round in January 2024 followed by Rokid's $70M round also in January 2024.

Another notable advancement is the Meta and Ray-Ban collaboration on Ray-Ban Stories AR glasses or the XREAL Air 2 glasses. At last, there are designer smart glasses or sunglasses for the consumers. Great design is key for AR technology to reach widespread market adoption within the consumer segment as young generations nor tech savvy veterans do not want to compromise.

While hand tracking is not a key feature in today's lightweight and low power AR glasses it is definitely at the forefront of MR devices. Apple Vision Pro has completely removed hand controllers in favor of gesture-, eye- and voice-interaction. Alternatives to dual hand controllers have seen its dawn with companies like Meta, Pico and Sony releasing improved gesture interaction or changed controller interaction methods. For Crunchfish Gesture Interaction these strides for mixed reality is a sign that shows that a great hand-tracking and gesture interaction solution is a more requested solution than ever. In China a mandatory product functionality is considered a "steel need" and this applies to hand-tracking for XR projects.

Automotive is another segment that has become a significant user of computer vision. With cameras or sensors analyzing data in and around the vehicle new General Safety Regulations (GSR) can be fulfilled. Current GSR regulations were announced in 2019 and start to come into force mid 2024. The automotive industry has been preparing for some time and more regulations will be added in the future in 2026 and 2029. This regulatory driver of computer vision technology is another opportunity for Crunchfish Gesture Interaction going forward.

Market update

In the fourth quarter of 2023 and at the very beginning of 2024 there have been two major events within XR, namely AWE EU in Vienna and CES in Las Vegas. Both events provide valuable information about technology and market trends.

The first event is the European version of the US based main annual Augmented World Expo event (AWE) normally held in June and it is an event specifically for immersed or augmented experiences and companies. Takeaways from AWE is that large corporations like Meta are building features to address enterprise needs, particularly within digital collaboration and remote working. Also lots of companies focus on fulfilling software needs to address various functional expectations for immersed experiences. For instance, how to create a lifelike interaction with a digital object or lifelike interaction with a digital living object like a bird, dog or similar. All powered by AI in the form of machine learning or natural language processing. Much needed functionality to move the immersed experience closer to reality.

The Consumer Electronics Show (CES) in Las Vegas is the largest consumer electronics show in the world. Eye-catchers within XR at CES were XREAL AR glasses, Sony's new VR headset and even though not present Apple created a buzz as they announced shipment of their Apple Vision Pro to start on February 2nd. In relation to Crunchfish Gesture Interaction there is a clear need for hand-tracking within XR,

especially in VR and AR use cases for screen replacement. Often these solutions come with a remote controller, a hand controller, mouse or touch panel and none of them are user friendly or intuitive.

The 4K display resolution provided in AR glasses today is definitely a viable alternative to a monitor, at least when on the go, when watching a movie or working on spreadsheets. A drawback for camera based gesture recognition solutions is the privacy concern when adding cameras to sleek AR glasses or sunglasses. It is important to secure privacy in this context as it may be seen as a concealed camera with the possibility to spy on others. Crunchfish's XR skeleton detects hands in a video frame and only processes the detected hands and proposes to blur everything else in the video feed.

An identified opportunity to Crunchfish Gesture Interaction is in Automotive. CES clearly shows how the vehicle has gone further away from being a mechatronics system to a high tech platform. New inventions for the automotive sector are spurred by all advancements from the electrification pioneered by Tesla. Touch, voice and gesture interaction are all considered as valid interaction methods for an improved in-cabin experience as the car gets smarter. Crunchfish's XR skeleton is optimized for front-facing camera setups as in XR use cases but also works well for user facing camera implementations found in automotive.

In the fourth quarter Crunchfish visited Ximmerse in Shenzhen, our customer since 2022. The roughly 200 people large company is seen as a startup among other larger companies. Ximmerse focuses on VR and simulation projects to address needs within enterprise and education. Their headset is equipped with Crunchfish's XR skeleton hand tracking.

Shortly into the new year an extension of the partnership with LogistiVIEW was signed. The collaboration brings gestures to LogistiVIEW's logistics platform for parcel picking and handling and is used together with industry leading AR glasses from Vuzix.

"I think a returning customer is a great token of appreciation of the work we do and a result of the quality of the products and services provided. We hope to further increase and improve the use of gestures in the logistics domain together with LogistiVIEW ", **says Fredrik Clementson, CEO Crunchfish Gesture Interaction.**

Product portfolio

Crunchfish's Skeleton platform and development team pave the way for many new solution areas and demonstrate technical flexibility for the Company's advanced gesture control technology. During the latest year, several new products were launched in parallel with existing products being further improved. Both XR Skeleton Stereo and the XR Skeleton Mono were upgraded with improved performance.
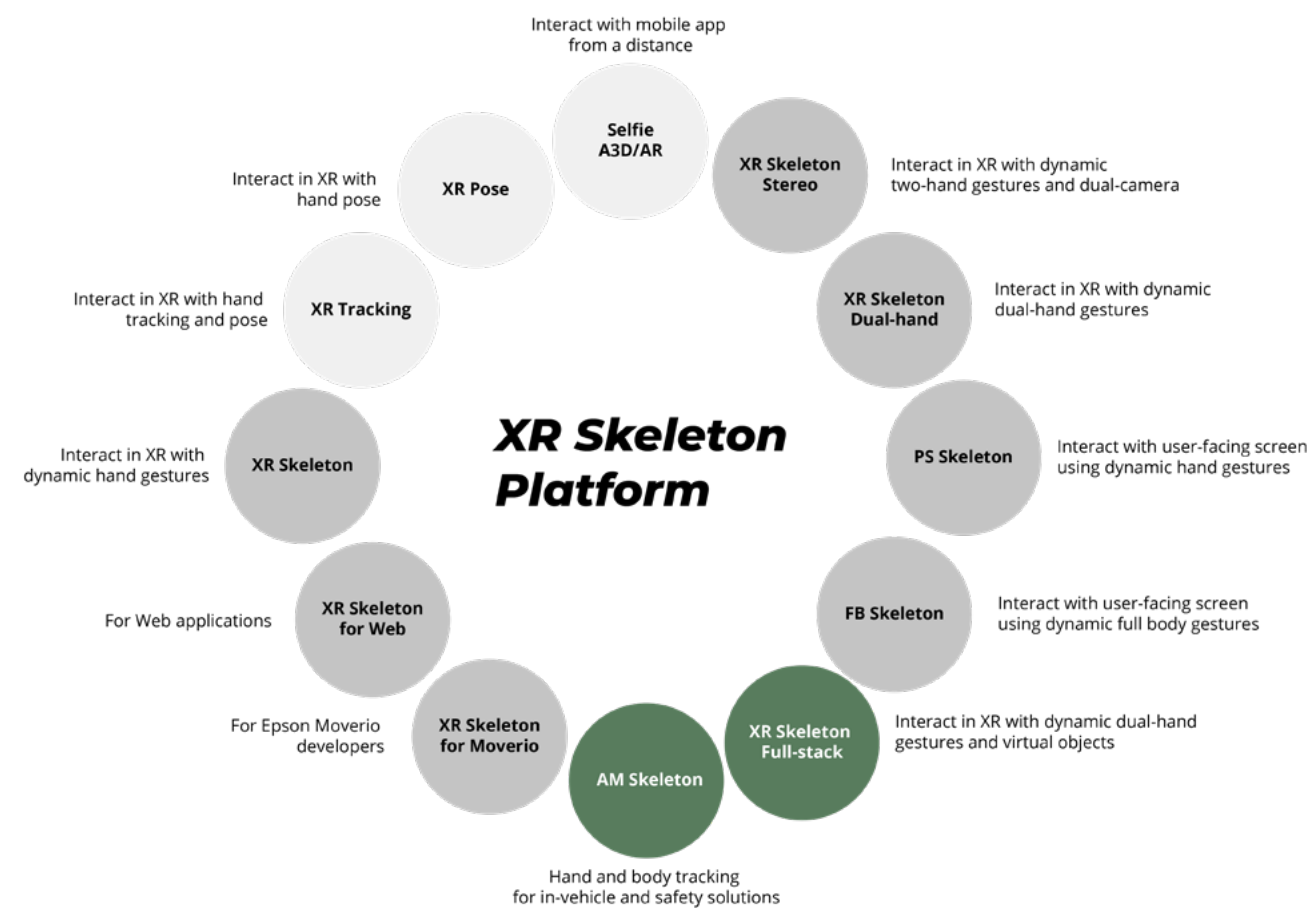
XR Skeleton

XR Skeleton is Crunchfish's fourth product generation, with each generation still part of Crunchfish's offering and targeting different use cases and types of hardware. The first product – Selfie A3D – is based on traditional image analysis and is adapted for mobile devices and tablets and interaction with simpler gestures. Recent years, the Company has focused on AR/ VR devices and products like XR Pose and XR Tracking were developed and optimized for different types of AR/VR devices. With each new product generation, the technology has become increasingly more based on neural networks, and the latest architecture found in XR Skeleton is based solely on neural networks.

With Crunchfish's proprietary tools and processes for, for example, generating training data, XR Skeleton has become the basis for the XR Skeleton platform.

Crunchfish's Skeleton platform, which is the foundation for the continued development of existing and new products, has generated new and updated product releases during the year. The platform itself consists of a number of different components including proprietary tools, camera rigs, proprietary neural networks, and processes to generate synthetic data.

XR Skeleton Stereo

XR Skeleton Stereo comes with tracking of 42 points simultaneously (21 points on each hand) and high precision in each point - even in depth as the distance between the camera sensors and the hands can be measured with high accuracy - Crunchfish enables realistic interaction with virtual objects in three dimensions. The development team has also worked on a new detector algorithm that is optimized for a stereo camera configuration and the detection of two hands at the same time.

Uses for XR Skeleton Stereo include interacting with virtual objects in AR/VR as well as new ways to track hands from a distance and control various screen functions and menus. By identifying all moving joints and contours of the hand and then linking these points (coordinates) to a skeletal structure, interaction with virtual objects is enabled that is lifelike for the user.

Launch of XR Skeleton 2.4 – One camera, two hands, three dimensions

XR Skeleton 2.4 became available to customers and partners in the fourth quarter 2023. This is the second generation of the flagship product XR Skeleton. In this upgraded version, the performance has increased by 20 percent and it supports two-handed interaction with both hands at the same time.

XR Skeleton 3.0

XR Skeleton 3 is under development and the updated API has already been released to customers. The new version will replace both XR Skeleton and XR Skeleton Stereo as it will work on any number of cameras, from 1 to many. This will simplify both maintenance and product adoption. To seamlessly work with an arbitrary number of cameras with flawless handover is a challenging task and the engineering team has worked hard to solve it. In customer discussion the new version has generated good interest as many are

looking to add more cameras as a response to the Apple Vision Pro headset that comes with 12 cameras.

XR Skeleton Auto

XR Skeleton Auto is a new product offering focusing on user facing camera implementations for public screens or automotive. This offering is intended to solve for the automotive customer segment and work started already in 2023. The collaboration with Lund University and the user facing camera projects has been valuable learning projects within this product area.
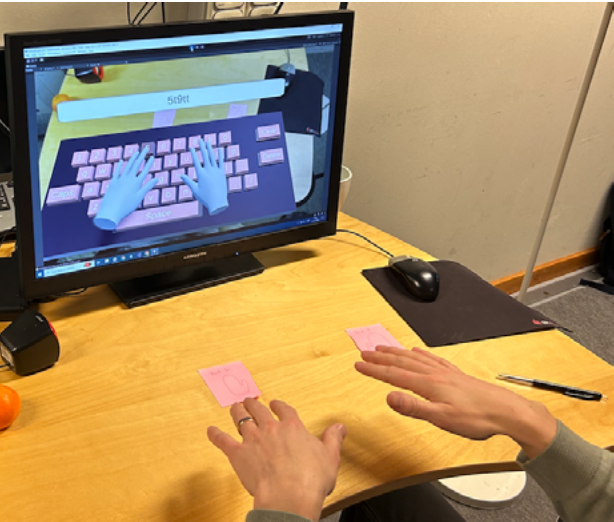
Financials

Financial report

Sales and earnings for 4th quarter

Net sales amounted to SEK 333 (30) thousand for the fourth quarter and operating expenses amounted to SEK 31,819 (13,652) thousand. EBITDA for the period amounted to SEK -7,476 (-8,284) thousand. Loss before tax for the fourth quarter amounted to SEK 26,815 (9,649) thousand and has been charged with amortization of intangible assets of SEK 918 (1,336) thousand, tangible fixed assets of SEK 134 (55) thousand and with impairment om of intangible assets of SEK 18,243 (0) thousand.

Sales and earnings for the year 2023

Net sales amounted to SEK 988 (6,187) thousand for the year and operating expenses amounted to SEK 68,944 (45,973) thousand. EBITDA for the year amounted to SEK -26,545 (-18,116) thousand. Loss before tax for the year amounted to SEK 49,305 (24,031) thousand and has been charged with amortization of intangible assets of SEK 4,281 (5,918) thousand, tangible fixed assets of SEK 323 (221) thousand and with impairment om of intangible assets of SEK 18,243 (0) thousand.

The decrease in net sales for the year is due to the commercial agreement with OPPO Mobile Telecommunications that was carried out in 2022. The agreement included an upfront fee of US$ 500,000 that was recognized as revenue in 2022. There is no corresponding agreement regarding the year 2023.

As a result of discontinuing the gesture business, balanced development costs related to this business have been written down. The write-down has affected the result for the fourth quarter and the full year negatively with SEK 18,243 thousand.

Investments

During the fourth quarter, the Group invested SEK 4,159 (3,559) thousand in intangible fixed assets and 0 (0) in tangible fixed assets.

During the year, the Group invested SEK 16,474 (13,555) thousand in intangible fixed assets and SEK 1,233 (60) thousand in tangible fixed assets.

Liquidity and financing

At the end of the year the Group's cash and cash equivalents amounted to SEK 30,725 (29,293) thousand. Cash flow from operating activities during the fourth quarter amounted to SEK -4,979 (-495) thousand. During November 2023, the company raised an additional SEK 42,7 million after issue costs in a new share issue.

Staff

As of December 31, 2023, the number of employees was 22 (20).

Risks and uncertainties

A number of different risk factors could impact Crunchfish's operations and industry negatively. It is therefore very important to consider relevant risks in addition to the Company's growth opportunities. Relevant risks are presented in the prospectus issued by Crunchfish AB in October 2023 and the annual report for FY 2022, which can be found at crunchfish.com.

Related party transactions

Group management and administrative staff are employed in the parent company Crunchfish AB. Reported sales in the parent company consists of income from services rendered for management and administration of the company's two subsidiaries.

Crunchfish Digital Cash AB has performed development and administrative services for the jointly owned company Blippit AB. Of the group's net sales for the fourth quarter, SEK 0 thousand (0) relates to fees invoiced to Blippit. Of the group's net sales for the year, SEK 0 thousand (141) relates to fees invoiced to Blippit.

In August 2023, Crunchfish AB entered into a financing agreement worth SEK 7.5 million with the Company's second shareholder, Corespring Invest AB, represented by the Chairman of the Company's Board, Göran Linder. The financing consisted of a loan of SEK 7.5 million that was due for repayment on February 9, 2024. The interest rate amounted to 7% per year. The loan was repaid in connection with the new issue that was carried out in November 2023. Total interest paid in 2023 amounts to SEK 102 thousand.

Sales and earnings for the quarter, parent company

The parent company's net sales amounted to SEK 4,253 (4,743) thousand for the fourth quarter and operating expenses to amounted to SEK -4,748 (-5,168) thousand. EBITDA for the period amounted to SEK 63 (-32) thousand. During the fourth quarter, the parent company invested SEK 0 (0) thousand in tangible fixed assets.

Sales and earnings for the year 2023, parent company

The parent company's net sales amounted to SEK 17,241 (17,916) thousand for the year and operating expenses to amounted to SEK -18,791 (-19,774) thousand. EBITDA for the year amounted to SEK 515 (111) thousand. During the year, the parent company invested SEK 0 (60) thousand in tangible fixed assets.

Major shareholders for Crunchfish AB (publ) as of December 31st 2023

Shareholder	number of shares	% of shares
Femari Invest AB (CEO Joachim Samuelsson & Petra Samuelsson)	7 500 000	18.92
Corespring Invest AB (Chairmain Göran Linder)	6 953 182	17.54
Nordic Underwriting ApS	2 327 319	5.87
Paul Cronholm (Founder & CTO)	1 101 601	2.78
Carlquist Holding AB	1 000 000	2.52
Mikael Kretz incl. company holdings	760 000	1.92
Håkan Paulsson incl. family and company holdings	625 000	1.58
Lars Andreasson incl. family holdings	461 000	1.16
Mats Kullenberg incl. company holdings	419 771	1.06
Granitor Invest AB	419 757	1.06
Total ten largest shareholders	**21 567 630**	**54.40**
Other shareholders (approx. 6 000)	**18 079 276**	**45.60**
Total	**33 039 167**	**100 00%**

Share price development during 6 months
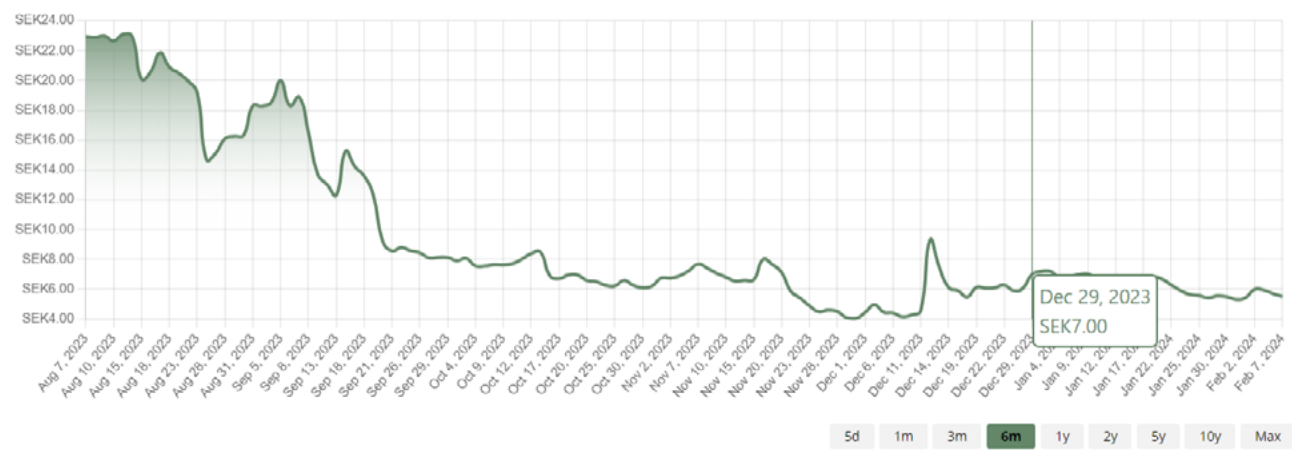
Financial calendar

Crunchfish AB publishes financial reports after each quarter. Upcoming reports are planned to be published according to the schedule below:

Year-end report 2023
February 15th, 2024, 8:30 am CET

Accounting principles

This report has been drafted according to the Annual accounts act (Årsredovisningslagen) and BFNAR 2012:1 (K3).

Auditor's review

This report has not been subject to review by the company's auditor.

Company information

Crunchfish AB (publ), corporate registration number 556804–6493, is a limited company seated in Malmö, Sweden.

Certified Adviser

Västra Hamnen Corporate Finance AB is the company's Certified Adviser.
E-mail: ca@vhcorp.se
Phone: +46 40 200 250

Further information

For further information, please contact:
Joachim Samuelsson, CEO
ir@crunchfish.com
Crunchfish AB (publ)
Stora Varvsgatan 6A
211 19 Malmö

Statement by the Board of Directors and the CEO

The Board of Directors and the CEO hereby assures that this interim report gives a fair overview of the company's operations, financial status, and result.

Malmö, February 15th, 2024

The Board of Directors
Göran Linder (chairman)
Robert Ekström
Susanne Hannestad
Joakim Nydemark
Joachim Samuelsson
Malte Zaunders

This information is information that Crunchfish AB is obliged to publish in accordance to the EU Market Abuse Regulation. The information was provided by the contact person above for publication on February 15th, 2024.

Group income statement (SEK)

	Q4 2023	Q4 2022	2023	2022
Operating income				
Net sales	333 351	30 462	987 834	6 186 821
Own work capitalized	4 159 342	3 559 004	16 473 949	13 555 352
Other operating income	554 585	387 677	2 089 237	1 975 692
Total operating income	**5 047 278**	**3 977 143**	**19 551 020**	**21 717 865**
Operating expenses				
Other external expenses	-4 436 547	-4 403 422	-19 691 267	-16 174 705
Personnel expenses	-6 769 661	-5 999 428	-25 076 057	-21 734 875
Depreciation and impairment of tangible and intangible fixed asset	-19 295 182	-1 391 024	-22 847 399	-6 138 787
Other operating expenses	-1 316 046	-1 856 868	-1 327 509	-1 856 868
Loss from participations in associated companies	-1 082	-1 682	-1 422	-67 871
Total operating expenses	**-31 818 518**	**-13 652 424**	**-68 943 654**	**-45 973 106**
Operating profit	**-26 771 240**	**-9 675 281**	**-49 392 634**	**-24 255 241**
Financial items				
Profit/loss from participations in group companies	0	-9 330	0	-9 330
Other interest income and similar profit items	15 538	37 638	274 708	254 527
Interest expense and similar loss items	-59 303	-1 799	-186 674	-20 488
Profit or loss from financial items	**-43 765**	**26 509**	**88 034**	**224 709**
Profit or loss after financial items	**-26 815 005**	**-9 648 772**	**-49 304 600**	**-24 030 532**
Profit or loss before tax	**-26 815 005**	**-9 648 772**	**-49 304 600**	**-24 030 532**
Taxes				
Tax on income for the period	-105 884	0	0	0
Profit or loss for the period/year	**-26 920 889**	**-9 648 772**	**-49 304 600**	**-24 030 532**
Key figures				
EBITDA	-7 476 058	-8 284 257	-26 545 235	-18 116 454
Earnings per share	-0,74	-0,30	-1,46	-0,77
Number of shares average	36 343 037	31 967 254	33 865 134	31 313 537
Number of shares at balance sheet date	39 646 906	33 039 167	39 646 906	33 039 167
Earnings per share after full dilution	-0,74	-0,30	-1,46	-0,77
Number of shares after full dilution average	37 717 537	33 093 888	35 239 634	32 527 045
Number of shares after full dilution balance sheet date	41 021 406	34 615 467	41 021 406	34 615 467

Group balance sheet (SEK)

	Dec 31 2023	Dec 31 2022
Assets		
Fixed assets		
Intangible assets		
Capitalized expenses for development work	26 132 777	33 508 932
Total intangible fixed assets	**26 132 777**	**33 508 932**
Tangible fixed assets		
Equipment	1 449 809	535 164
Total tangible fixed assets	**1 449 809**	**535 164**
Financial assets		
Participation in associated companies	67 231	68 653
Total financial assets	**67 231**	**68 653**
Total fixed assets	**27 649 817**	**34 112 749**
Current assets		
Current receivables		
Account receivables	48 941	1 547 884
Other receivables	1 951 018	449 987
Prepayments and accrued income	1 139 804	1 089 417
Total current receivables	**3 139 763**	**3 087 288**
Cash and bank balances		
Cash and bank balances	30 725 483	29 292 563
Total cash and bank balances	**30 725 483**	**29 292 563**
Total current assets	**33 865 246**	**32 379 851**
Total assets	**61 515 063**	**66 492 600**

Group balance sheet cont. (SEK)

	Dec 31, 2023	Dec 31, 2022
Equity and liabilities		
Equity		
Equity attributable to parent company shareholders		
Share capital	1 823 758	1 519 802
Other contributed capital	318 492 646	276 001 326
Other capital including profit or loss for the year	-268 054 284	-218 749 684
Total equity	**52 262 120**	**58 771 444**
Long-term liabilities		
Lease liabilities	957 492	0
Total long-term liabilities	**957 492**	**0**
Current liabilities		
Lease liabilities	460 031	383 485
Accounts payable	1 046 542	1 914 397
Other liabilities	784 093	777 788
Accrued expenses and accrued income	6 004 785	4 645 486
Total current liabilities	**8 295 451**	**7 721 156**
Total equity and liabilities	**61 515 063**	**66 492 600**
Key Figures		
Equity-assets-ratio	85,0%	88.4%
Debt-to-equity ratio	2.0%	0.7%
Interest-bearing net debt	n/a	n/a

Changes in the group equity (SEK)

	Q4 2023	Q4 2022	2023	2022
Equity at beginning of period/year	36 487 824	46 024 740	58 771 444	55 843 499
Share issues	51 209 977	21 478 445	51 209 977	26 077 445
Issue costs	-8 503 355	-553 379	-8 503 355	-589 378
Translation difference	-11 437	0	-41 360	0
Warrant premiums	0	1 470 410	130 014	1 470 410
Profit or loss for the period/year	-26 920 889	-9 648 772	-49 304 600	-24 030 532
Equity at end of period /year	**52 262 120**	**58 771 444**	**52 262 120**	**58 771 444**

Group cash flow statement (SEK)

	Q4 2023	Q4 2022	2023	2022
Operating activities				
Operating profit or loss	-26 771 240	-9 675 281	-49 392 634	-24 255 241
Adjustments for non-cash intems	20 580 880	2 808 671	24 128 377	7 618 349
Interest received etc.	36 402	-106 378	58 428	30 585
Interest paid	-110 725	28 437	-151 488	9 748
Income tax paid	0	0	0	0
Cash flow from operating activities before changes in working capital	**-6 264 683**	**-6 944 551**	**-25 357 317**	**-16 596 559**
Cash flow from changes in working capital				
Decrease(+)/increase(-) in receivables	1 489 060	5 085 290	-52 475	194 235
Decrease(-)/increase(+) in current liabilities	-203 266	1 364 623	497 749	-450 381
Cash flow from operating activities	**-4 978 889**	**-494 638**	**-24 912 043**	**-16 852 705**
Investing activities				
Investmetn in technology development	-4 159 342	-3 559 004	-16 473 949	-13 555 352
Investments in equipment	0	0	-1 232 856	-60 202
Cash flow from investing activities	**-4 159 342**	**-3 559 004**	**-17 706 805**	**-13 615 554**
Financing activities				
Share issue	42 706 622	20 925 065	42 706 622	25 488 067
Loans from shareholders	0	0	7 500 000	0
Repayment loans from shareholders	-7 500 000	0	-7 500 000	0
New loans financial leasing agreements	0	0	1 232 856	0
Amortization of financial leasing agreements	-87 306	-25 864	-198 818	-177 099
Warrant premiums paid	0	1 470 410	130 014	1 470 410
Cash flow from financing activities	**35 119 316**	**22 369 611**	**43 870 674**	**26 781 378**
Change in cash and cash equivalents	25 981 085	18 315 969	1 251 826	-3 686 881
Cash and cash equivalents at beginning of period/year	4 769 953	10 832 578	29 292 563	32 755 502
Exchange rate difference in cash and cash equivalents	-25 555	144 016	181 094	223 942
Cash and cash equivalents at end of the year	**30 725 483**	**29 292 563**	**30 725 483**	**29 292 563**

Parent company income statement (SEK)

	Q4 2023	Q4 2022	2023	2022
Operating income				
Net sales	4 252 741	4 743 233	17 240 870	17 915 726
Other operating income	554 585	387 677	2 053 852	1 948 733
Total operating income	**4 807 326**	**5 130 910**	**19 294 722**	**19 864 459**
Operating expenses				
Other external expenses	-2 764 896	-2 563 081	-9 958 369	-10 147 595
Personnel expenses	-1 979 701	-2 193 907	-8 818 661	-9 199 908
Depreciation of tangible and intangible fixed asset	-3 010	-4 972	-12 040	-20 646
Other operating expenses	0	-405 611	-2 286	-405 611
Total operating expenses	**-4 747 607**	**-5 167 571**	**-18 791 356**	**-19 773 760**
Operating profit	**59 719**	**-36 661**	**503 366**	**90 699**
Financial items				
Profit/loss from participation in group companies	-48 176 713	-28 700	-48 176 713	-28 700
Other interest income and similar profit items	315 464	206 870	866 680	541 405
Interest expense and similar loss items	-28 564	30	-138 140	-2 486
Profit or loss from financial items	**-47 889 813**	**178 200**	**-47 448 173**	**510 219**
Profit or loss after financial items	**-47 830 094**	**141 539**	**-46 944 807**	**600 918**
Profit or loss before tax	**-47 830 094**	**141 539**	**-46 944 807**	**600 918**
Taxes				
Tax on income for the period	0	0	0	0
Profit or loss for the period/year	**-47 830 094**	**141 539**	**-46 944 807**	**600 918**
Key figures				
EBITDA	62 729	-31 689	515 406	111 345
Earnings per share	-1,32	0,00	-1,39	0,02
Number of shares, average	36 343 037	31 967 254	33 865 134	31 313 537
Number of shares at balance sheet date	39 646 906	33 039 167	39 646 906	33 039 167
Earnings per share after full dilution	-1,26	0,00	-1,32	0,02
Number of shares after full dilution, average	37 717 537	33 093 888	35 239 634	32 527 045
Number of shares after full dilution, balance sheet date	41 021 406	34 615 467	41 021 406	34 615 467

Parent company balance sheet (SEK)

	Dec 31, 2023	Dec 31, 2022
Assets		
Fixed assets		
Tangible fixed assets		
Equipment	39 099	51 139
Total tangible fixed assets	**39 099**	**51 139**
Financial assets		
Participations in group companies	121 798 538	123 057 790
Total financial assets	**121 798 538**	**123 057 790**
Total fixed assets	**121 837 637**	**123 108 929**
Current assets		
Current receivables		
Account receivables	48 941	1 547 884
Other receivables	757 005	211 928
Prepayments and accrued income	1 128 561	1 089 417
Total current receivables	**1 934 507**	**2 849 229**
Cash and bank balances		
Cash and bank balances	29 789 506	28 509 210
Total cash and bank balances	**29 789 506**	**28 509 210**
Total current assets	**31 724 013**	**31 358 439**
Total assets	**153 561 650**	**154 467 368**

Parent company balance sheet cont. (SEK)

	Dec 31, 2023	Dec 31, 2022
Equity and liabilities		
Equity		
Restricted equity		
Share capital	1 823 758	1 519 802
Total restricted equity	**1 823 758**	**1 519 802**
Unrestricted equity		
Profit brought forward	191 574 281	148 440 683
Profit or loss for the year	-46 944 807	600 918
Total unrestricted equity	**144 629 474**	**149 041 601**
Total equity	**146 453 232**	**150 561 403**
Current liabilities		
Accounts payable	643 293	978 120
Liabilities to group companies	3 500 000	0
Other liabilities	560 617	766 808
Accrued expenses and accrued income	2 404 508	2 161 037
Total current liabilities	**7 108 418**	**3 905 965**
Total equity and liabilities	**153 561 650**	**154 467 368**
Key Figures		
Equity-assets-ratio	95,4%	97.5%
Debt-to-equity ratio	0.0%	0.0%
Interest-bearing net debt	n/a	n/a

Changes in parent company equity (SEK)

	Q4 2023	Q4 2022	2023	2022
Equity at beginning of period/year	151 576 704	128 024 388	150 561 403	123 002 008
Share issues	51 209 977	21 478 445	51 209 977	26 077 445
Issue costs	-8 503 355	-553 379	-8 503 355	-589 378
Warrant premiums	0	1 470 410	130 014	1 470 410
Profit or loss for the period/year	-47 830 094	141 539	-46 944 807	600 918
Equity at end of period /year	**146 453 232**	**150 561 403**	**146 453 232**	**150 561 403**

Parent company cash flow statement (SEK)

	Q4 2023	Q4 2022	2023	2022
Operating activities				
Operating profit or loss	59 719	-36 661	503 366	90 699
Adjustments for non-cash items	3 010	4 972	12 040	20 646
Interest received etc.	291 856	120 030	650 400	461 235
Interest paid	6 548	0	-103 028	-2 516
Income tax paid	0	0	0	0
Cash flow from operating activities before changes in working capital	**361 133**	**88 341**	**1 062 778**	**570 064**
Cash flow from changes in working capital				
Decrease(+)/increase(-) in receivables	480 248	5 745 330	914 722	-512 003
Decrease(-)/increase(+) in current liabilities	184 514	1 300 420	-297 547	-60 949
Cash flow from operating activities	**1 025 895**	**7 134 091**	**1 679 953**	**-2 888**
Investing activities				
Investmetn in equipment	0	0	0	-60 202
Disposal of shares in subisdiaries	0	16 300	0	16 300
Repayment shereholder contributions	0	0	0	370 000
Loans provided to group companies	-10 520 953	-11 779 034	-43 417 461	-31 412 918
Cash flow from investing activities	**-10 520 953**	**-11 762 734**	**-43 417 461**	**-31 086 820**
Financing activities				
Share issue	42 706 622	20 925 065	42 706 622	25 488 067
Loans from shareholders	0	0	7 500 000	0
Repayment loans from shareholders	-7 500 000	0	-7 500 000	0
Warrant premiums paid	0	1 470 410	130 014	1 470 410
Cash flow from financing activities	**35 206 622**	**22 395 475**	**42 836 636**	**26 958 477**
Change in cash and cash equivalents	25 711 564	17 766 832	1 099 128	-4 131 231
Cash and cash equivalents at beginning of period/year	4 089 445	10 655 507	28 509 210	32 560 241
Exchange rate difference in cash and cash equivalents	-11 503	86 871	181 168	80 200
Cash and cash equivalents at end of period/year	**29 789 506**	**28 509 210**	**29 789 506**	**28 509 210**