KAMBRIA

Fueling the Robotics Economy

White Paper

Version 2.0

June 15, 2018

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[Unless the context requires otherwise, in this white paper the terms "founders," "we," "us" and "our" refer to KI, and all dollar ($) amounts set forth herein refer to United States dollars.]

Abstract

Kambria is a decentralized open innovation platform managed by Kambria International ("KI") that will foster a collaborative ecosystem, with the goal of dramatically accelerating the development and adoption of the world's most advanced robotic technologies.

Current progress in the robotics industry is impeded by siloed development, wasted labor, and high startup costs. As a result, the pace of innovation is needlessly slowed. Kambria's creation was born out of our desire to accelerate this process by engaging a community of developers and tinkerers, providing them with the necessary tools, and connecting them through market demand.

Drawing inspiration from other widely popular open source operating systems like Linux and Android, the core of the Kambria platform is an open repository comprised of a high-level behavior library and modular hardware and software components for robotics. The repository is designed to maximize reusability and collaboration during development.

Using game theory and token economics, KI is incentivizing the Kambria community to reach a pareto-optimal state of continual cooperation of investors, companies, contributors, and manufacturers, and users are empowered to collaborate and help the ecosystem grow rapidly.

Our goal is to design and deliver the most capable yet affordable consumer robots at 10x the speed, efficiency, and ease. The founders of KI believe that the Kambria platform will unlock substantial innovation in markets that are primed for technological transformation. Imagine a world where your ill stricken daughter doesn't have to miss out on playing with her grandma 10,000 miles away; where she can be safe alone; a world where she is given automated care around the clock; and where she can be educated by the best teachers in the comfort of her home. We believe this reality can be achieved in the near future with the Kambria robotics innovation platform built by the community.

Interactions on the platform are facilitated by the Kambria token to be created, issued and deployed by KTI ("KAT"). Companies can use KAT to issue bounty challenges which are awarded to projects when fulfilled. Individuals or teams are rewarded with KAT for designs or code they contribute. Manufacturers earn KAT through production of robots and robotic parts. Community members use KAT to promote specific projects and fundraise for the shared technology. KAT can also be used to fairly capture the value to pay for enforcement of legal rights created by Kambria platform participants and sustain the growing community. If the Kambria platform is successful in encouraging innovation in the robotics industry, the founders will consider the application of the Kambria platform to innovation in other industries in the future.

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1. Introduction

1.1. Shortfalls of Modern Robotics

Within just a few decades of Alan Turing proposing the question: "Can machines think?"[i] and Joseph Engelberger developing the first robot prototype, robotic machines were adopted on a massive scale in the industrial work space.[ii] Robotic arms can be found on many assembly lines, from manufacturing automobiles to preparing meals. The revolution of industrial robots was fueled by advancement in computing power and artificial intelligence. The former allowed robots to be programmed. The latter gave robots complex reasoning ability. More recently, robots have employed sensors to interact with the real world to handle a wide range of tasks. [Large economic value, captured by specialty machines working around the clock, hastened the use of robotics on all manufacturing lines.iii]

Although robots have succeeded in finding their place in manufacturing, they have not yet been widely adopted in the home. After more than half a century of research, progress has been slow in making affordable robots that can address our everyday needs in the home. Traditional development processes used by robotics companies result in high cost production, which is not effective for the everyday consumer market. Only robots programmed to do very simple household tasks, such as vacuuming or mowing, were able to capitalize on the small profit margins resulting from consumer products. Highly functional robots, including the Honda Asimo[iv] that can walk up the stairs and Toyota's Human Support Robot[v] that can fetch, are limited to research facilities due to their expensive price tags. OhmniLabs does not believe that this will be commercially viable in the near future.

It is clear that the problems robotics engineers struggled with from the beginning of robotic development are still prevalent today.

#1. Lack of good interfaces and abstraction layers for software, electrical, and mechanical systems.

- Leads to bias towards monolithic and non-modular designs

- Results in a requirement for major redesign effort for any modifications

- Makes the design hard to reuse by others and continues the cycle of waste

- Reduces efficiency since no common point is available for developers to work off in parallel
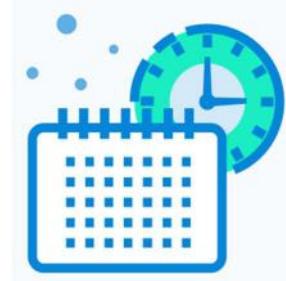
#2. Lack of tools, semantics, and methods to share parts of designs in distributed fashion.

- Many engineering domains involved in robot design (mechanical, electrical, etc.) lack good tools for collaboration and sharing

- Missing semantic linkages across systems, including software design to electrical engineering, and electrical engineering to mechanical engineering

- Currently, the development materials are a chaotic tangle of repos, directories, sheets of BOM parts, text assembly instructions, slicer settings, and supplier names in scattered local servers and cloud storages

#3. Significant portions of expended effort are implicitly discarded.

- Duplicated effort by robotic manufacturers to find good suppliers, select parts, negotiate terms, verify paperwork, and assemble an in-house team

- Very few practical standards or instructions to capture the comprehensive start-to-end process information

#4. Robotic applications are slow, expensive, and hard to make. Innovation is slowed.

- Inadequate infrastructure and high-level abstractions for robot programming

- Lack of open platform and development tools accelerate innovation

- Most explorative development is bootstrapped and not supported

- Capital funding is only offered to large scale or mature projects

#5. Slow turnaround, high minimums, and poor interfaces from "traditional" manufacturers.

- These design problems significantly slow development speed

- They are bottlenecks in the design/build/test cycle

- They result in higher costs, time, and effort

Due to these challenges, the current pace of robotics innovation is needlessly slowed. The purpose of the Kambria platform for open innovation in robotics is to free the robotics industry from these impediments and accelerate the evolution of robotics technologies. Our founders believe that the future is too important to be controlled by a select few entities and the ethical responsibility of the robotics community is to ensure that the development of robots will be more equitable and utilitarian. The robotics community must find ways to collectively govern, and benefit from the coming revolution in robotics.

1.2. Ohmni Robot

The founders of Kambria had previously started a robotics company called OhmniLabs, Inc. ("OhmniLabs") in 2015. It was built upon the premise that to accelerate adoption of robotics in homes, a new type of company was needed. Being far away from home themselves, the founders could relate to the needs for affordable robots that bring families closer. So the founders set out to design robots with modular components and utilize lean, toolless manufacturing. To close the cost gap, they were ultra-focused on iteration speed. Reusability and integration were the cornerstones of our fabrication process, allowing for orders of magnitude less capital spent, and a fraction of the development time.

In the short span of just two years, they were able to prototype 10 generations of a telepresence robot. The net result, the Ohmni robot, quickly became one of the leading products in the consumer market at an unmatched price point. Ohmni's mobility, range, simple controls, and easy access appealed to users of all ages and backgrounds. Using the Ohmni robot, families separated by countries, continents, or oceans could feel the distance fade away. Children confined by their illnesses could still interact with their classmates and teachers. Ohmni was touted by the New York Times as Rosie the Robot from "The Jetsons"[vi] and CNN reported that "Ohmni robot makes video chats feel like they are in real life."[vii]

The founders had successfully brought a low-cost high-value robot to market by practicing a philosophy of ultra-lean, fast, and agile manufacturing[viii]. The goal has always been to enhance the entire process, overcome existing shortfalls encountered in the industry, and jump-start a revolution in robotics.

1.3. Mission Statement

KI's mission is to accelerate the process of innovation, enabling faster, cheaper, and easier development and adoption of technologies.

KI believes that fostering an open collaborative ecosystem, where every contribution can easily be shared, manufactured, and implemented will be revolutionary. Companies can benefit from the collective contribution from the community to build custom applications without having to employ teams of experienced researchers who are very difficult to find and employ. End users can enjoy the higher quality of life afforded by more available tech products and services. KI believes that a combination of reduced costs, cutting edge technologies, and swift delivery will spur rapid adoption of the Kambria Platform by companies, developers, and manufacturers. This cycle of innovation will pave the way for the *next* wave of innovations to provide value for people across the world.

In order to achieve this vision, OhmniLabs is granting to KI a non-exclusive royalty-free license of necessary components of its Ohmni robot, consisting of a robotics repository, high-level behavioral library, and modular components, as the basis for the Kambria Platform. KI will own the applicable intellectual property rights associated with the platform.

The founders named the platform **Kambria**, after the Cambrian Explosion, 500 million years ago, when an accelerated evolutionary rate gave rise to biodiversity and abundance. They believe the Kambria Platform will be the catalyst for a similar explosion in robotic innovations.

1.4. Solution Enablers: Blockchain and Crypto-economics

"Bitcoin gives us, for the first time, a way for one Internet user to transfer a unique piece of digital property to another Internet user, such that the transfer is guaranteed to be safe and secure, everyone knows that the transfer has taken place, and nobody can challenge the legitimacy of the transfer. The consequences of this breakthrough are hard to overstate."

- Marc Andreessen, inventor of the first browser, thought leader and top VC.[ix]

"Whilst open source has always had powerful network effects, the additional skin in the game through direct financial stake puts open-source token-backed initiatives on steroids."

- Jamie Burke, Outlier Ventures[x]

Robotics developments today can be explained using game theory.[xi] Players in this game have two choices: **Cooperate** to share knowledge and technology (C), or **Defect** and remain secretive (D). This analysis can be encoded into a standard payoff matrix as seen in Table 1 below. As it stands, the industry is at state (0,0), i.e., robot developers choose to both defect and innovate within their own silos because there are no incentives to share information. On the other hand, the risks to share are so great that no robot developer is willing to deviate. So, the entire system is stuck in the worst-outcome Nash equilibrium.[xii]

	C	D
C	(2,2)	(-1,3)
D	(3,-1)	(0,0)

Table 1 - Payoff matrix for robotics industry

The founders believe that the Kambria Platform can tip the incentives of the game to achieve a much better outcome where everyone is incentivized to share which will greatly accelerate innovation in robotics.[xiii] By adjusting the weights of the incentives, KI believes that it can significantly increase the rewards for cooperation while further increasing the cost of defection: KI can design a Grim-trigger strategy[xiv] in which the participants are encouraged to cooperate in the beginning and are subjected to heavy penalty if they defect.

This change of incentives is where blockchain comes in. Blockchain and crypto-economics provide unique mechanisms to deliver the desired rewards and enforce penalties to achieve pareto-optimality. Blockchains enable systems that are open, transparent, trustless, and fully decentralized, overcoming the opacity and inefficiency of traditional economic models when applied to collaboration.

The Kambria Platform is built on blockchain. By introducing crypto-economics into the robotics development cycle, the Kambria Platform can be leveraged to reward cooperation and penalize defection to (1) achieve a dramatically lower barrier of entry for individuals and small teams to collaborate; (2) provide economic incentives to contribute; (3) capitalize on network effects to aggregate compelling technology; (4) provide intermediation for the end-to-end robotics business challenges; and (5) detect and denounce violations of legal rights to reduce the "free rider" effect.

Bootstrap Community Quickly

with dramatically lower barrier to entry and financial incentives.

Cultivate Network Effect

with the growth of token value for #HODLer.

Discourage Free-Riders
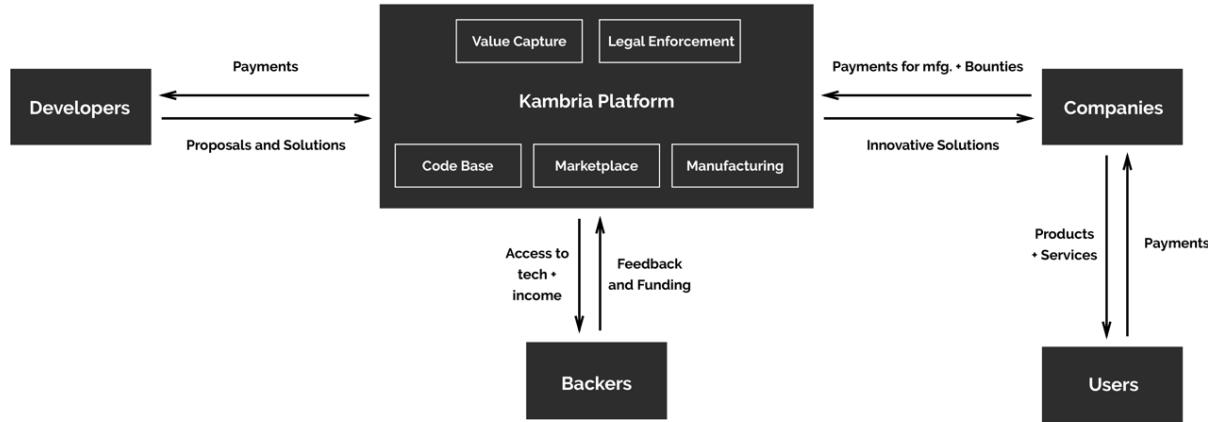
through penalties and legal actions.

Reward First-Movers

via tokens and attribution on the blockchain.

Section 2 discusses how robotics development is tokenized by utilizing KTI's deployment of smart contracts and the ERC20 token standard on Ethereum.[xv] Section 2.1 describes how code development and ownership can be attributed on-chain using smart contracts. Section 2.2 introduces KI's open competition system using KAT and tournament designs based on game theory and also shows how KAT owners can stake their assets on-chain to create even more value-driven incentives. Section 2.3 discusses how stakeholders in the Kambria ecosystem use KAT for payment and the novel ways this design can reduce transactional friction. Sections 2.4 and 2.5 explore how KAT can further facilitate value capture and legal enforcement. Finally, Section 2.6 describes the future work to fully develop the Kambria ecosystem, and explores the multitude of verticals that Kambria platform could be used to scale broad social impact.

2. Kambria Architecture and Utility Token Model

The Kambria Platform architecture is made up of five pillars: Code Base (KDNA), the innovation marketplace, the manufacturing alliance, value capture, and legal enforcement. Each pillar directly addresses the shortfalls of modern robotics development detailed in Section 1.1 and is designed to maximize the incentives for collaborative development based on game theory listed in Section 1.4.

Interactions on the platform are facilitated by KAT and Kambria Karma. KAT is a native ERC20 utility token created, issued and deployed by KTI. Its main functions are to enable access to the Kambria Platform, reward participation, and align incentives for all stakeholders in the ecosystem.

Kambria Karma is not an ERC20 token, but rather a non-tradeable ledger entry for wallet addresses. Kambria Karma is used to track actual work performed. It is also an incentive to promote useful work and is awarded for concrete contributions. Details will be explained further in subsequent sections.

2.1. Code Base (KDNA)

Modularity is the essence of the Kambria Platform, and the basis for reusability and efficient collaboration.

Kambria DNA (KDNA) is the platform's semantically rich module management and build system. It crosses hardware, firmware, software, electrical, and mechanical boundaries to directly specify all components and subcomponents of a built robot. For example, the motor system that gives OhmniLabs' Ohmni telepresence robot mobility is a combination of electrical engineering (motor controller board), firmware (commutation algorithms), mechanical designs (housing, mounting, etc.), manufacturing processes, sourcing, assembly, tools, cabling, software (API), and other components.

The design of Kambria KDNA is inspired by a combination of the *npm*[xvi] node.js package manager and the Android Open Source Project's *repo*[xvii] tool ("AOSP").

Each module is a Git repository which can be hosted on any cloud service (i.e., GitHub, Bitbucket), a developer's own server, or perhaps stored in IPFS in the future for decentralization. KDNA codebase architecture is designed to be pragmatic by maximizing reuse of the tools that everyone is familiar with and already using.

Modules can be linked to KI's distributed module registry (the "Kambria Code Base") which is a smart contract on the Ethereum blockchain. Registering the module only needs a publicly-accessible URI to the repo, and a unique name. This process does not certify any particular amount of work done or ownership, but links the repo into the Kambria Code Base. Furthermore, every module/repository has the ability to hold, receive and send funds, and participate in on-chain mechanisms (voting, signaling, staking, etc.).

Each module also contains a root-level file which is a semantic description of the contents of the module. This function makes the system semantically processable — i.e., subdirectory A contains the firmware that's used on the PCB in subdirectory B, which is part of this particular CAD'ed mechanical assembly in subdirectory C.

The module files also list dependencies on other modules by global name, with version constraints (like npm). The build system, like repo, can scan the on-chain registry and fetch all modules at appropriate versions from all repositories. The modules are included into a directory hierarchy (like AOSP) and tools can be used to do things like compile across modules, generate bill of materials information, generate assembly instructions, export files for 3D printing, etc. In the future, Kambria developer tools will allow this semantically-rich data to be easily viewed and modified across all repositories.

Additionally, KI will explore opportunities to improve game theory and product interactions with the robotics and crypto communities. Some examples may include: tipping projects/users with KAT, leaderboards and surfacing projects that hold the most KAT, reputation systems, other applications of Kambria Karma, periodic community-wide signaling rounds to estimate the value of each project, etc. By

bringing projects and users on-chain, KI has the flexibility to evaluate which approaches create the strongest incentive alignment.

The combination of open source codebase, component language, and development tools makes up the core of KI's robotics innovation platform. KDNA maximizes freedom, prevents lock-in, and empowers all current collaborative methods.

2.2. The Innovation Marketplace and Innovation Utility.

The innovation marketplace is at the heart of KI's open innovation model. KAT are used as a signaling mechanism as well as a reward when value-adding work is completed.

Top-down signaling is driven by the desire for new technology to be added to the Kambria ecosystem, where the party or parties needing the technology want to find experts that can provide solutions. For example, a large company that wants to apply robotics to their own business may need a custom sensor, manipulator, or control logic. They can use KAT to submit a bounty that describes the project terms: the work to be done, the judging criteria, expert judges from the community,[xviii] tranches or timing, and a payout schedule. These terms are encoded in a smart contract, with links to additional bounty data off-chain. KAT used for the bounty are staked in the smart contract while the bounty remains open.

Bounties can range from small ($100-$5K USD) to large ($100K-500K USD) to enormous ($1M+ USD). Furthermore, others can join existing open bounties by staking their own KAT to increase the size of the prize pool, essentially directing the development of solutions based on the signaled needs of the community.

KI intends to include tranches/multiple tournament rounds in the bounty design as there may be financial overhead for innovative but poorly funded teams in some cases. If included, an early tranche based on a detailed project proposal may win a small set of funds to be used by the team for materials/spending required to reach the next tranche.

K-Prize is the name given to a set of widely publicized bounties/competitions with large prizes (typically $500k+ USD) that are run by the Foundation and/or KI. These prizes will target and push forward the development of key capabilities that unlock new value/application for robot platforms. They are modeled after the XPRIZE Challenges and other robotics competitions like the DARPA Challenges, RoboCup, as well as the various navigation or picking challenges held at various robotics conferences. They are key for demonstrating to the public the increasing usefulness and capabilities of the Kambria platform.

KI also recognizes that many corporations may need assistance purchasing KAT for bounties and thus the Foundation and/or KI is dedicating a team and part of the holdings (in the form of the Community Fund) to guide/assist companies in making the process as easy as possible.

2.3. The Manufacturing Alliance and Manufacturing Utility

The Manufacturing Alliance will be a collaborative partnership where top manufacturers share knowledge, resources, and maintain APIs/standards. The Manufacturing Alliance goal is to provide a network of ultra-lean and ultra-fast robotics manufacturing centers around the world.

Members of the alliance are committed to the open process of turning KDNA into fabricated robots quickly. This capability reduces the need for the supply chain, sourcing, negotiating, paperwork handling, stocking, and manufacturing work currently being duplicated by every maker and robotics company. By sharing knowledge on ultra-lean production, manufacture scaling, metal 3D printing, and other innovative processes not yet common in the industry, participants in the Kambria Platform will have a considerable advantage over traditional competitors.

The Manufacturing Alliance will initially be led by OhmniLabs with strong interest from existing partners in Taiwan and Japan. KI and/or the Foundation intends to invite other interested manufacturers to join.

OhmniLabs is also the founding member of the Manufacturing Alliance. Based on its expertise in design, engineering, and manufacturing, OhmniLabs is able to fulfill orders right at the start of the Kambria Platform deployment.

OhmniLabs prioritizes speed, reusability, and efficiency in every process, including supply selection and 3D printing. In fact, OhmniLabs is the first company to bring large scale robotics to production via additive manufacturing. Currently, OhmniLabs has 50 printers capable of printing 120+ Ohmni-sized robots per month. OhmniLabs can add capacity at about 100 robots per month every month with a sub-team of four (scales accordingly). This was achieved through OhmniLabs own design and manufacturing of 3D printers.

KAT are used for access and payment on the Manufacturing Network. For payments in KAT, the order can be directly processed by a smart contract. The total cost for a particular KDNA is set by the manufacturer and enables the manufacturer to charge an appropriate margin for the work involved. KI anticipates the manufacturer can sell KAT on an exchange to obtain required fiat, currency for suppliers outside of the Kambria Platform, or KI and/or the Foundation may maintain a reserve (replenished periodically) to facilitate exchange for manufacturers.

2.4. Value Capture and Community Sustainability Utility

KAT are also used to capture the value created by the Kambria Platform with the intent of making the Kambria community sustainable and not dependent on donations (as is the case for many other large non-profits or open source communities). It is also intended to be a key piece to economically incentivize the community to participate in and add value to the Kambria Platform.

Over the life of a robot, KI has identified three major value capture points:

- When a robot is manufactured

- When a robot is sold or leased for profit/commercial use

- When a robot performs a value-adding task that someone is willing to pay for

KI will seek to ensure that each value capture point is recorded with the creation of new value. For instance, prior to the complete robot being manufactured, the individual components have little individual value. At the point at which the robot is completed and becomes usable, some of the created value should go to the manufacturer and some of the value returns to the community and individuals that made the completed robot possible.

The second capture point is after a manufacturer has done the work with KI to find specific product-market fit. The company must invest capital to be able to achieve understanding customers, branding and marketing, and other costs required to reach the market. Thus, the customer is willing to pay some amount Y for the robot that enables the manufacturer to have a profit. A fair part of this value should be captured to reward the Kambria community.

The third capture point occurs where robotic labor based on highly-capable robots becomes fungible. Instead of a customer paying for an entire robot, it purchases robot labor on demand (robotics as a service). In the future, the robot may be able to submit some privacy-preserving proof of work on-or-off chain as it performs requested tasks, and the user must pay the robot correspondingly. A part of the value created by robotic labor should go back to the Kambria community.

When a value capture point occurs, the fee is enforced either directly by smart contract (if payment is received in KAT, Ether, or potentially other cryptocurrencies) or the receiving entity is obligated to submit the fees to a smart contract (if payment is in fiat currency) according to the terms of the KI license. If necessary, they must purchase KAT at market price on an exchange or via an exchange service facilitated by KI and/or the Foundation to obtain the necessary KAT. The on-chain transaction method is preferred, though for practicality KI may allow fiat transactions to happen in accordance with regulations.

Fees in the form of KAT are then sent to the KI smart contract on-chain, and a set of rules handles the distribution of tokens to contributors.

The goal with fees is to keep them reasonable enough that the Kambria community is well rewarded for the hard work, but the advantage for companies to use Kambria is significantly greater than if they were to do the work on their own. The time and cost of building a new robotics team from scratch, spending development dollars, and then having to risk that what was developed can reach the market is very risky and is the challenge borne by robotics companies today. A reasonable fee for usage should be significantly more attractive by any company looking to transform its business or provide a service to users through robotics.

2.5. Legal Enforcement Utility

In the Kambria ecosystem, a great amount of ideation, technology, capital, and experience will be amassed and shared. KI believes that keeping the technology and the core platform **open** will be essential to maintaining the pace of rapid innovation. The Kambria Legal Compliance team will protect the collective work of the Kambria community by pursuing compliance and enforcement through legal action against free-riders and violators of the KI license.

Similar to bounties, anyone in the Kambria community can flag a possible violation by creating a case (a smart contract) that can track/run votes and receive a pool of staked token donations. Each case will also link to off-chain collaboration like a wiki page or Slack channels where those interested in the case can confer, collect and share evidence, and coordinate enforcement subject to compliance with any relevant laws on third party funding of litigation.

The primary signaling mechanism, called KambriaVote, will essentially be similar to a long-running CarbonVotexix on-chain. KI wants to incentivize the Kambria community to participate in signaling without any economic loss as potential cases may gather momentum for a long period of time even prior to any legal action being initiated. Implicitly, every KAT holder abstains. A mapping is retained of every address in support and at any block, the total KAT held by supporting addresses signals the total level of support. KAT holders are free to change their vote at any time by sending another transaction with their updated vote.

All open source projects deal with the free-rider problem, where those who aren't contributing to the project derive large economic gain that isn't shared with the people who performed work. The combination of significant advantages to participating in the system (sharing in community rewards, access to fast-evolving technology, etc.) and a disadvantage/penalty to being a free-rider should help motivate honest participation.

2.6. Future Development

After the Beta network launch, KI will continue to develop the platform and expand the utility of KAT in the following areas:

Future Development for Innovation Marketplace

Another unique feature that KI has designed into the innovation token flow that provides game-theoretical incentives. KI introduces the concept of Kambria Karma. Karma is a non-transferrable ledger entry per account that entitles the holding account to share in a bonus of the use fees generated by the Kambria platform. The key is that Kambria Karma cannot be generated from capital alone. The exact mechanism will be developed in the future.

The long-term incentive from holding Kambria Karma gives KI the mechanism to solve the first-mover problem by providing a strong economic advantage to those who participate in issuing bounties. This structure enables the work to be shared openly across the entire community while rewarding those who participate early and often.

Future Development for Manufacturing Alliance

Any KDNA design conforming to the Kambria manufacturing standards and vetted by a panel of experts can be fabricated, in as little as a few days. The time savings is tremendous and the ability to collaborate increases significantly because work can be immediately duplicated from person to person — just like software.

KI will pay special attention to reducing friction and making the model work for payments directly in KAT[xx] (for highly involved Kambria participants) and for payments in fiat or other cryptocurrencies (i.e., ETH, Bitcoin). There are added complexities because a typical manufacturer will likely have to make many fiat purchases from suppliers. KI outlines the solution to these challenges below.

For payments in fiat currency, the order is manually recorded on-chain by the manufacturer. The manufacturer will use some of the fiat currency to pay fiat-based expenses directly, but might use the same percentage license fee to buy KAT (from any exchange or from Foundation and/or KI reserve) and then send them to the KI smart contract for value capture.

As mentioned above, each manufacturer is required to post a stake/deposit of KAT when the smart contract is created to show good faith and involvement in the community. This is also to "pay" for the trust required for the manufacturer to accept and process the order. The exact amount of the deposits and the conditions will be determined at a later date. The first set of manufacturers will accordingly be vetted by the Foundation and/or KI, but the founders expect to develop rules to demonstrate this process and allow new manufacturers to join over time.

A future alternative KI is considering that still requires trust (but moves the point of trust to the Foundation and/or KI instead of each manufacturer) is to have a Foundation and/or KI non-transferrable *entry credit* similar to Factom's entry credits which can be purchased directly from the Foundation and/or KI.

The resulting fiat currency is held in the Community Fund. Users then pay the manufacturer on-chain via the manufacturer's smart contract, and the manufacturer can close the loop by sending the credits back to the Foundation and/or KI, which releases the fiat currency. Careful design of this system can make this entire process transparent to the end user.

KI envisions that many companies and individuals may start interacting with Kambria Platform by purchasing the latest available robotics platforms to use in fiat currency, until they want to start making their own customizations and become familiar with the KAT and KNDA codebase. This is actually a significant win for the community as it establishes a stable flow of fiat currency and other currencies into KAT.

This system is designed to avoid lock-in and maximize the freedom of participants. KDNA encodes comprehensive information so that individuals or companies can go directly to the end suppliers themselves and source and fabricate/assemble all parts. Manufacturers provide time saved, reduced costs from economies of scale, and the ability to then clone or make multiple designs with no more effort than adjusting the number in the order.

Future Development for Value Capture

Bottom-up signaling recognizes the importance and foresight of leading developers in the community in proposing new and important work. Every project or individual in the Kambria ecosystem can propose a GoFundMe or Kickstarter style project describing the work to be done and a desired contribution amount. Via a traditional curation/voting process, the Kambria community can surface the top proposals, which are again stored on-chain as smart contracts essentially using the same bounty mechanism with a few different bits.

As bounty work is completed and validated, the smart contracts will disburse funds either immediately (based on multi-sig or other voting done by the appointed bounty judges) or by setting up a distribution schedule if the funds are to be released over time. KI believes that bounties distributed over time can provide financial stability to the winning teams and also incentivize them to keep engaging with the Kambria community. In either case, additional logic can be set up to be automatically triggered when the competition is concluded, such as ongoing maintenance contracts for the winning team to continue improving its code or designs.

Future Development for Legal Enforcement

KAT can be used as both a signaling mechanism and a community fundraising method for legal compliance and enforcement.

This mechanism also enables external interest in the case. If KAT has a large market cap and participation in these votes is high, potentially large amounts of dollars could be signaled in support of legal action. This alone may bring a spotlight to violators and incentivize them to come into compliance.

At certain levels of signaled support (may be hardcoded or may be based on relative support level), the Foundation's and/or KI's management will review and engage legal counsel to make a determination on the cost to the community, chances of success, and expected return given the available data. This information will be made available on the case (off-chain) and votes can be conducted to determine if legal action should proceed now or wait for more support/evidence/etc. This voting occurs with the same mechanism though, in this case, a specific future block number is selected at which point the tally will decide the outcome.

Once a vote passes to initiate action, donations will be accepted via staked KAT in the smart contract. Based on the estimated costs of the case, once the fundraising amount reaches the threshold, legal action will start. KI and/or the Foundation will manage withdrawing (proportionally) from the pool to fund the legal team. As with bounties, spending/withdrawals from the pool might generate Kambria Karma in proportion to all the pool participants.

If the case fails, any unspent KAT will be returned proportionally to the stakers. If the case succeeds, the awarded amount in KAT that is owed as a license fee will be returned to the community via the value capture mechanism (above section). The KI license should include a reasonable excess penalty when violation of terms is proven. The excess penalty in KAT (minus legal fees) will be returned to the staked pool and proportionally refunded to all contributors. If the award is large, then it is entirely possible that the stakers will receive more KAT than they staked, though no return should be expected by stakers.

Token Holder Perks Program

A large community of roboticists together is a valuable resource. Based on this, the Foundation and/or KI intends to negotiate and manage a perks program for all KAT holders, such as discounted access to makerspaces, co-working spaces, or parts/tools/supplies.

To participate in the program, the roboticists only need to hold a minimum of one KAT in a wallet and be able to validate ownership of that wallet. Subsequent tiers ($500+, etc.) will give the roboticists access to additional perks/discounts as KI and/or the Foundation negotiates them. More details will be announced in the future.

The founders believe innovation in many other industries has problems similar to robotics. But the future of the human species depends on our ability to continue to innovate and create new technology. They hope that the experience with the Kambria platform can be applied to other industries. With the Kambria experience, the founders are considering how to redefine and accelerate the innovation process in other industries.

Together, the founders believe that the experience with the Kambria platform can help us build ecosystems in which enthusiasts, universities, startups, and big corporations can come together and pave the way for the next wave of innovations to provide value to the people of the world!

3. Team and Advisors

3.1. Founding Team

Dr. Thuc Vu, Co-founder, AI & Game Theory

Thuc is a serial entrepreneur with multiple company acquisitions, the last one by Google. He has deep expertise in game theory, tournament design, and multi-agent systems. He earned his Ph.D. from Stanford and B.S. from Carnegie Mellon, both in Computer Science. Thuc is a social entrepreneur in Vietnam, involved in several community projects.

Jared Go, Co-founder, Robotics & Blockchain

Jared is an avid maker and roboticist, previously CTO and founding member at a networks startup. He has extensive experience in blockchain, AI, real-time graphics, VR, mechanical engineering, and electrical engineering. Jared is a Stanford Graduate Fellow, and has a B.S. in Computer Science from Carnegie Mellon University.

Tingxi Tan, Co-founder, Cloud Computing and Blockchain

Tingxi has a background in cloud computing, network infrastructure and distributed system design. He has been active in Crypto Investment since 2010. He was responsible for building the global scale cloud infrastructure at a networks startup. Tingxi graduated with an M.Sc. in Computer Science at the University of Calgary and a B.Sc. in Applied Math at Western University.

3.2. Leadership Team

Prof. Manuela Veloso, AI and Robotics

Manuela Veloso is the Herbert A. Simon University Professor in the School of Computer Science at Carnegie Mellon University. She was the President of AAAI (Association for the Advancement of Artificial Intelligence) until 2014, and the co-founder and a Past President of the RoboCup Federation. She is a fellow of AAAI, IEEE, AAAS, and ACM. She is an international expert in artificial intelligence and

Dhana Pawar, Marketing

Dhana Pawar is a seasoned business and product management executive. She has launched award-winning, innovative products with an emphasis on delighting consumers. She has led teams to develop compelling applications which led to strategic acquisitions and mergers. Her other expertises include product management, product strategy, end-to-end product development, and partnerships.

Ned Semonite, Partnerships

Ned Semonite brings a wealth of experience as a seasoned product and marketing professional with over 25 years of experience in bringing innovative hi-tech products and services to enterprise and consumer markets. Mr. Semonite contributed significantly to the development of the videoconferencing industry. In his various past leadership roles, Ned worked to sign and develop telco channel partners, then rose through the organizations in a series of management roles including VP of product management, VP of engineering, and EVP of worldwide marketing.

Prof. Tra Vu, Finance

Tra has a background in Financial and Civil Engineering. She earned her Master's in Financial Engineering and her PhD in Transportation Planning & Engineering from the NYU Tandon School of Engineering. Tra currently teaches at her alma mater and was responsible for leading her previous company in designing the first city-wide Transit Signal Priority system in New York City.

Dr. Minh Nguyen, Research

Graduated from the Albert Einstein College of Medicine with a PhD in Genetics, Minh has gained a broad research expertise in cancer study and its genetic root. She received her B.S/M.S in Biochemistry from George Mason University, and was awarded the best graduate student for her class. She believes that an active open AI and robotics platform will advance research in every field exponentially, especially in Medical Sciences.

Lien Cao, Vietnam Operations

Lien has over a decade of experience in operation management. She was the program manager of the Advance Program in Computer Science at the University of Science in Vietnam. She also co-founded BeRich Corporation and has been serving as its managing director. Lien believes in leading from the heart and wishes to do little things to make the world a better place.

3.3. Advisors

Simon Seojoon Kim, CEO, Hashed

Simon Seojoon Kim is CEO and founding partner of Hashed, a leading crypto fund based in South Korea. He is a Blockchain evangelist and organizer of Hashed Lounge, a premier Blockchain Seoul meetup community. Prior to Hashed, Simon was a serial entrepreneur and co-founded numerous companies. He served as Chief Product Officer at Knowre, an ed-tech startup that was named one of the World's Top 10 Most Innovative Companies in Education by Fast Company.

Loi Luu, Co-founder, KyberNetwork

Loi Luu is a researcher working on cryptocurrencies, smart contract security and distributed consensus algorithms. He is also a regularly invited speaker at Bitcoin and Ethereum workshops such as DevCon2 and EDCON.

Loi believes in the force of the Ethereum and Blockchain technology. Much of his work revolves around this community. He developed Oyente, the first open-source security analyzer for Ethereum smart contracts. Loi also cofounded SmartPool, another open source project which embraces decentralization of mining pools in existing cryptocurrency. He continues to champion decentralisation and trustless properties of the Blockchain with KyberNetwork, taking inspiration and developing value for the community.

George Li, Co-founder, WeTrust

George is an ex-Googler who previously co-founded CottonBrew, a Stanford StartX computer vision company. Prior to that, he held roles in Corporate Strategy and Infrastructure at Google, and was a consultant at McKinsey. He holds an M.S. in Management Science Engineering from Stanford and a B.S. in Electrical and Computer Engineering from Rutgers.

Long Vuong, CEO and Founder, Tomochain

Long Vuong is CEO and founder of Tomochain, a public blockchain infrastructure providing innovative solution to the scalability problem with the Ethereum blockchain. He is often invited as guest speaker of many reputable blockchain events around the globe. Prior, Long Vuong was co-founder and the former project lead of very successful NEM blockchain (New Economy Movement). He is a PhD candidate in Economics at UMass-Amherst, Massachusetts, U.S

Roger Lim, Co-founder, NEO Global Capital

Roger Lim is an experienced angel and blockchain investor. He is the Founding Partner of NEO Global Capital and an advisor for projects like Bluzelle, Qlink, CoinFi, Thekey, Tomocoin, 0Chain,

Switcheo, Open Platform, and nOS. He is also a successful entrepreneur who founded Webvisions, an Asian cloud hosting company.

Mike Hodges, Managing Director, ATA Ventures

Mike is a Managing Director of ATA Ventures and an active member of ATA's New Investment team. He serves on the Board of Directors at Clustrix, Billeo, Fredio, Modern Video, TrilibisMobile, uCirrus, Shocking, and Zoosk. He has sourced or provides backup support to other current portfolio companies including AccelOps, EdgeWave, Jobvite, and Medagate. Mike joined ATA Ventures in 2006 as a Venture Partner, after having built a reputation as a successful CEO and interim CEO. Mike is credited with several successful turn-around efforts, including Tellium, a Telecom Networking company that began as a technology spinout from Bellcore in 1997 (Tellium completed a public offering of $1.5B in 2001). Furthermore, Mike filled CEO or iCEO roles at a variety of venture-backed technology startups, including Cygnet Systems, Biometric Imaging, SkyStream, NanoGram, Bandwidth9, Onetta, Silvan Networks, and MEMX.

Dr. David Nguyen, Chairman, Regulus

Dr. David Nguyen is President of Vietnam Chamber of Commerce in Singapore (VietCham Singapore) where he advise various Vietnamese and International enterprises with their local and global business expansion. He is also Chairman of Regulus Investment and Capital Holdings, a private equity funds in Singapore, Vice President of Vietnamese Association in Singapore. David has assisted and helped over 120 Vietnamese SMEs and startups to expand to global market through Singapore Gateway. On the blockchain focus, David is advisor to many ICOs and co-author the book in Vietnam: "Blockchain and Investment in ICOs: The basics, the pathway to financial freedom " together with Dr Loi Luu, Ceo and co-founder of Kyber Network.

David holds a Ph.D from Université du Maine – France, Double MBA in Marketing and Strategy from Nanyang Business School – Nanyang Technological University, Singapore.

Lily Sarafan, CEO, Homecare Assistance

Lily Sarafan is CEO of Home Care Assistance, the leading consumer health company in the $100B in-home care market, with a mission to change the way the world ages. Lily is also an investor and advisor for startups and VC firms, and a mentor for 500 Startups, StartX, and Endeavor. She serves on boards for high-impact organizations including the Stanford Alumni Association, the Freeman Spogli Institute, the BerkeleyHaas Center for Building Innovation Economies, Shared Studios, and the Women's Alzheimer's Movement. Lily holds an M.S. in Management Science and Engineering and a B.S. in Science Technology and Society with a minor in Middle Eastern Studies from Stanford University, where she was Eben Tisdale Fellow and Class President.
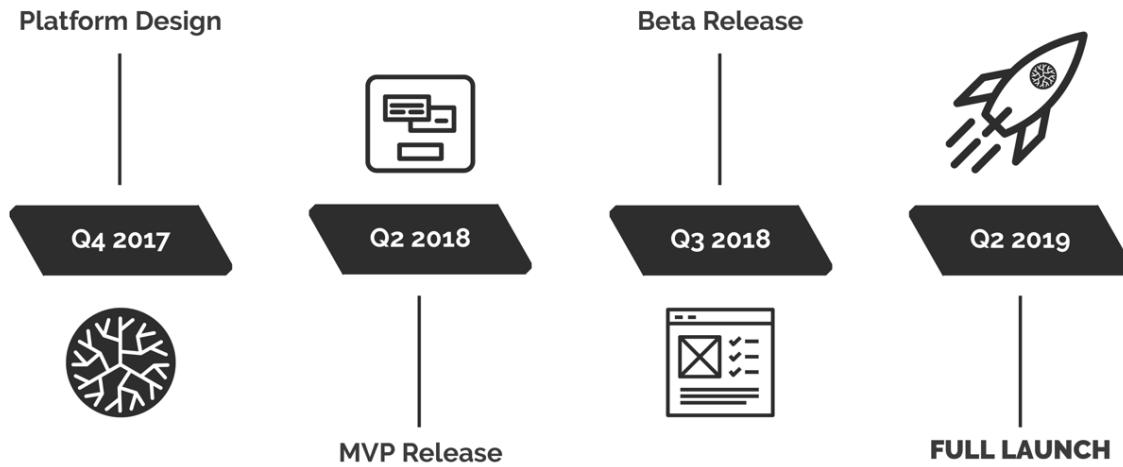
Matt DiMaria, CEO, Eye-Fi

Matt is a transformational leader with a record of accomplishment in Internet of Things (IoT), Software as a Service (SaaS), and software in consumer and business-to-business markets. He has demonstrated success in consistently developing high performance teams that contributed to generating over $2 billion of shareholder value by delivering market leading products and services for thousands of companies and millions of consumers. Matt is currently working as CEO in Residence (CIR) at Alpine Investors, based in San Francisco, California.

Darryl Burton, Policy and Product Lead, CMS

Darryl has solid expertise in program planning and management, staff and team coordination, budget and resource allocation, cost reduction, and contract and proposal negotiation honed from wide-ranging experience within healthcare, government, and private sectors, and the military. Darryl is a policy and product lead at Centers for Medicare & Medicaid Services.

4. Roadmap

4.1. Kambria Platform Roadmap

From Day 1, roboticists and companies will be able to collaborate with KI by purchasing Ohmni as a platform and customizing the hardware and software themselves.

We will ensure that the smart contract and codebase development, as well as the core robotics platform development can proceed in parallel without any hard dependencies.

The individual areas below will also be developed in parallel and iteratively based on feedback from the community:

Code Base

- Complete first pass Git + smart contract linkage, along with DApps to view and manage the linkage, account balances, etc.

- Deploy smart contract registry for the Kambria codebase

- Tipping, bounty award mechanisms implemented

- Implement KDNA compilation/dependency language

- Create the guidelines, standards, and any extra tools for format interchange/collaboration

- Material to guide and help other teams onboard who aren't as familiar with the crypto space to begin participating

- Design codebase/game theoretic new part/process reduction

Marketplace/Bounties

- Assemble teams of expert roboticists for judging panels

- Establish roadmap and timeframes for issuance of KI and/or Foundation bounties

- Implement and iterate on test bounty contracts that allow for the range of flexibility desired: judging, immediate and periodic payouts, multiple rounds, tournament design, etc.

- Ensure the linkage to on-chain bounty contracts and the off-chain wiki, docs, and other materials is clear and usable

Manufacturing

- Build relationships with interested alpha partners and suppliers beyond our existing set

- Develop draft specification 1 of the target supported materials and processes with KMA members

- Develop tools for automated manufacturability assessments for subcomponents of KDNA

- Implement manufacturer smart contracts to accept KDNA orders and KAT payment

- Test end-to-end KDNA orders with each process flow (3D printing, PCB assembly, etc.)

- Implement linkages to fee capture in smart contract

Value capture

- Implement contract for returning value to both KAT and Karma holders

- Implement community fund smart contracts, managed by KI and/or Foundation Multi-sig

Legal

- Lock down KI source license with legal team and ensure compatibility with other licenses currently being used

- Keep top legal teams on retainer

- Develop legal case smart contracts and mechanisms for signaling, voting, and staking

Phases and Milestones

January 2018 - March 2018: Kambria MVP

1. Deploy key smart contracts on testnet

2. Have GitHub repos linkable to the testnet contracts

3. Ohmni robots available to order as a base platform. Continue building out APIs and SDKs based on needs and engage other roboticists in guiding the development

June 2018 - September 2018: Kambria Beta

1. KDNA v0.1 available. KDNA v0.1 describes all internal component files (mechanical, electrical, software) and the relationship between files. Ancillary data like BOM, build instructions and images are also available

2. Open up by KTI of KAT smart contracts on Mainnet

3. Open up KambriaVote smart contracts on Mainnet

4. Open up bounty smart contracts on Mainnet

5. Purchase of Ohmni Robot and Ohmni DevKit using KAT.

6. Visualize projects /codebase that uses KDNA specifications.

7. Bounties and competition modules available

8. Orders are fabricated into real-world parts as fast as possible

9. Issue initial top-down bounties on Mainnet and start bringing the new technology into Kambria codebase for all to share

10. Start initial bounties for add-ons, enhancements, and other valuable technology contributions to Kambria. These may start off-chain and move to on-chain once the smart contracts are ready

- **Q2 2019: Full release**

1. Full release of Ohmni KDNA in the Kambria Code Base under an open source license

2. All bounty systems and DApps active, released, and usable

3. Token perks holder program available

4. Extended utility in manufacturing, value capture, and legal enforcement.
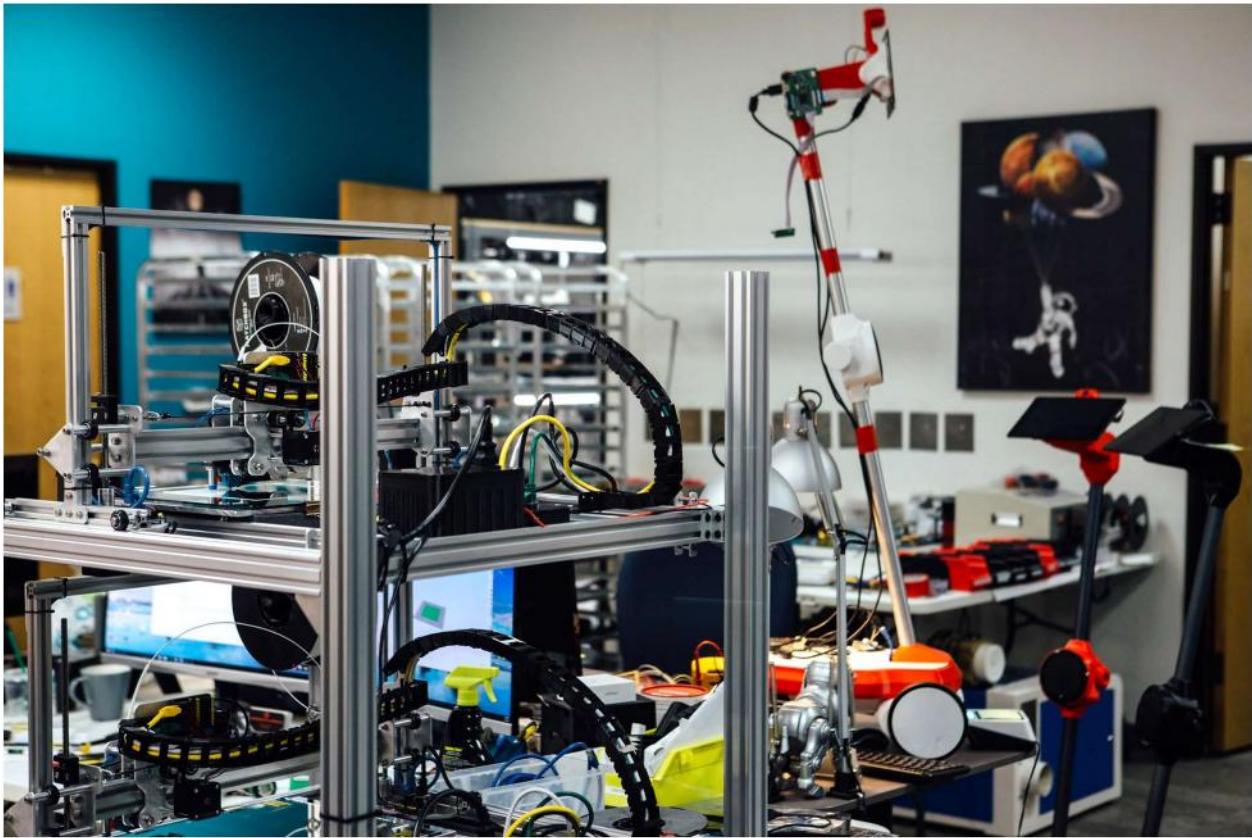
4.2. Kambria Robotics Technology Roadmap

To jumpstart the Kambria codebase, provide the software and hardware for Ohmni on a royalty free "open source basis," Ohmni is a state-of-the-art telepresence robot which represents 10 generations of iteration and development encompassing more than 2 years.

Through KI, roboticists can immediately modify Ohmni's KDNA and customize it for their specific tasks. Part of the motivation of the OhmniLabs' founder for founding KI and the Foundation comes from the many requests OhmniLabs received for custom robots. OhmniLabs realized that for many interesting applications, Ohmni was already 98 percent of the way there and only needed the last 2 percent customized. Without being an open, modifiable platform, the only alternative for these individuals and companies to have a custom robot would be to build the robot they need from scratch, or manually "hack up" other robots in a non-scalable way. KI enables innovative exploration at a significantly reduced cost.

OhmniLabs will continue to develop the telepresence robot, as well as market, manufacture, support, sell, and contribute funds to KI and/or the Foundation. The robot will continue to be called Ohmni. OhmniLabs' goal will be to provide the premiere telepresence robot on the market at the lowest possible cost.

In addition, OhmniLabs will be building and releasing another version of the Ohmni robot on Kambria Platform intended for developers, similar to TurtleBot, Aibo, Nao, and Pepper platforms. However, instead of the long two- or three-year cycles, continuous development by KI will ensure a release cycle of every six months.

OhmniLabs has an internal roadmap to develop the following listed technologies, which can potentially be released and open on Kambria Platform, with a specific licensing agreement in place. These will be the necessary building blocks for more effective and flexible robotics of the future.

Navigation/localization/positioning

- Assisted navigation (CMU)

- Partnering with intel on ZR400 integration

- Autonomous mapping + navigation with high level behavior language

- Cloud map storage, merging, refinement

- Cloud UIs for interactive mapmaking and semantic tagging

- Visual odometry infrastructure (partner)

World interaction

- Low cost 3 DOF arm + high level positioning language

- Low cost 1-2 DOF gripper

- VR teleoperation + predictive haptic feedback (also for training)

Sensory API — vision

- TensorFlow-Based transfer learning system — cloud training, local model deployment ultra streamlined

Sensory API — speech

- Tuned hotword detection and command detection

- Scriptable commands and interactions

Audio and camera hardware improvements

- Choice of camera modules, open system (HDR, zoom)

- Distributed mic and positional array

- Ultra-natural sound/voice at low frequencies (subwoofer)

General autonomous behavior

- Neural network for attention model to observe environment and learn

Embedded system work

- Ultra-high power computation platform (Tegra X1 or laptop class)

Demos

- Demo — Autonomous plant watering

- Demo — Periodic photo inspection of things along a route

- Demo — Tennis ball pickup and organizing

- Demo — tour guide, delivery tasks (cobots-style capabilities)

- Demo — Smart and unobtrusive following and monitoring/checking on person

- Demo — look for an object in certain areas, pick it up and bring it over

Low-cost/telepresence platform v2

- Above enhancements plus floor-to-ceiling height adjustment

- Cost reductions

High capability platform v1

- Open, ZR400, new cameras, etc.

Multi-agent coordination platform

OhmniAPI

- Integrated motion and actions

- Couple sensing primitives

Design and form factors

- Explore material like cloth, etc.

- Base form factors like Holonomic drive, outdoor/off-road version, and above water/underwater version (partner with first or other)

5. Appendix

5.1. Ohmni Specs

Physical specs

- Height: 5"

- Weight: 21 lbs.

- Base dimensions: 17.8" x 14.1"

- Front wheels diameter: 6"

- Rear wheel diameter: 3"

Core system

- Aaeon UP board

- Intel® AtomTM x5-z8350 Processor (2M Cache, 1.44 GHz up to 1.92 GHz) CPU with 64 bit architecture; Quad Core

- 2GB DDR3L-1600

- 16GB eMMC

OS and Software

- Android 7.0, custom modified by OhmniLabs

Connectivity

- WiFi: 802.11a/b/g/n/ac

- Cellular: 4G/LTE via your own WiFi hotspot

Display

- Custom 1280x800 IPS ultra-thin modular display, 10-point touchscreen

- Maximum brightness: 350 nits

- Completely modular - HDMI input for video and USB for touchscreen

Cameras

- 2x 2MP OV2710 based USB cameras

- Field of view: ~160 deg, option for larger

- Pixel size: 3um for low-light sensitivity

- Peak dynamic range: 69dB

Mic and speaker

- Omnidirectional, far-field mic

- DSP with echo cancellation and automatic gain control

- Touch controls for volume and mute

Battery and charging

- 96Wh LiFePO4 battery

- Integrated 20W charger with cell balancing

- Integrated cell protection

Charging dock

- 24V 3A output, 100-240V 50/60Hz AC adapter

- ChargeSense

- Weight/dimensions

Motors

- 30W capable Ohmni Glide Drive design, ultra quiet

- 14-bit absolute rotational odometry via AMS magnetic encoder

Neck servo and USB hub

- Integrated Herkulex DRS-0101 servo

- OhmniLabs 4-port embedded USB 2.0 hub including FTDI serial chip and 5V 3A
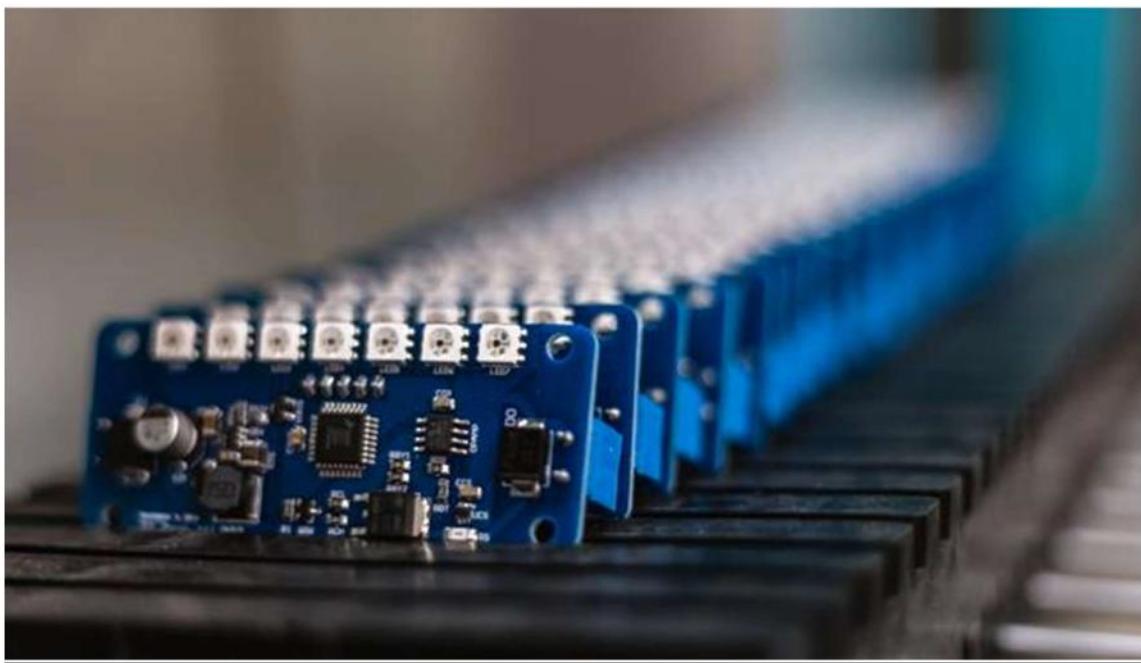
Output Base LEDs

- 3x 24-bit RGB animatable LED strips

5.2. Ohmni Tech Stack

Beyond the design, hardware, and physical components of the robot, OhmniLabs will provide a royalty free, non-exclusive license to KI for this firmware and software. These include:

- OhmniLabs version of Android-x86 7.0, with custom Intel video acceleration improvements designed for the UP board

- OhmniLabs USB touchscreen firmware, making it possible to re-use low-cost multi-touch tablet screens with any base embedded system

- OhmniLabs GlideDrive firmware — brushless motor controllers with custom commutation

    logic based on an absolute magnetic encoder, supports advanced position and velocity control, torque limiting, odometry, and more

- OhmniLabs hardware accelerated compositing camera HAL driver

- OhmniLabs vision-based autodocking system

- Ohmni API — high-level, media-rich JS language for programming robot behavior

- Cloud-based control and programming infrastructure

5.3. OhmniLabs Manufacturing Capabilities

Capability to additive manufacture print:

- **Up to size XYZ**

- **PLA or PETG**

Capability to waterjet cut:

- **Aluminum**

- **Stainless steel**

- **Acrylic**

Capability to laser cut and etch:

- **Acrylic**

- **Felt**

Capability to fabricate cable assemblies

Capability to fabricate PCBs and do PCB assembly:
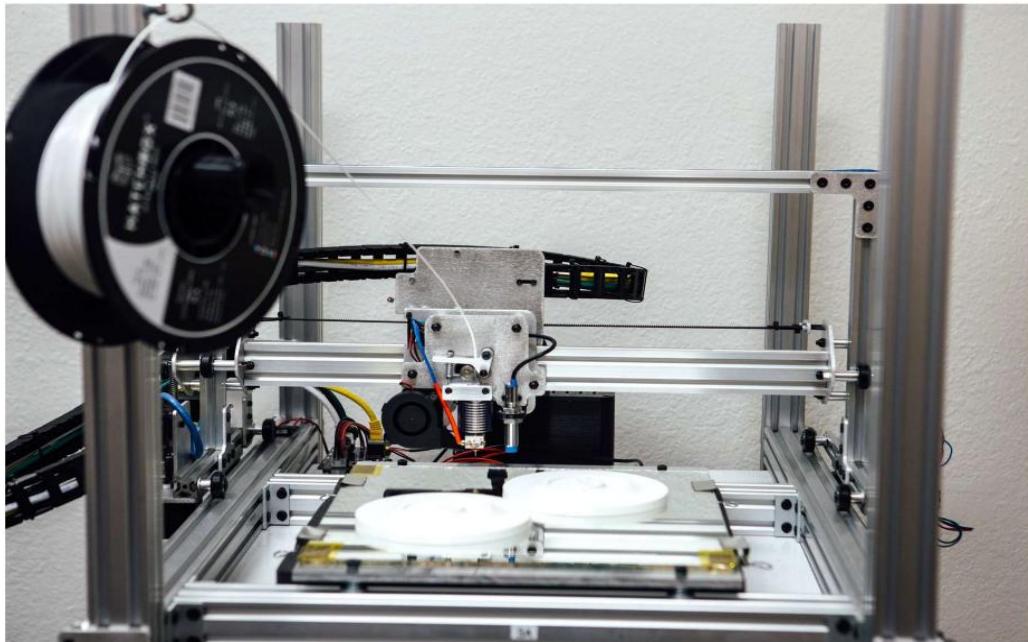
- Parts from Digikey or Mouser

Capability to source hardware/fasteners:

- McMaster, etc.

- Amazon

- Aliexpress

Coming soon: Ability to 3D print metal (a key game changer)

Coming soon: Ability to 3D print packaging material

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[xv] https://ethereum.org/.

[xvi] https://www.npmjs.com/.

[xvii] https://source.android.com/source/using-repo.

[xviii] The Foundation and/or KI favors contests with quantifiable and measurable results, so that judge selection is more efficient, i.e., can avoid having to do as detailed audits for impartiality. Thus, the judges

can act more like executors, uploading proof-of results off-chain and referencing them on-chain when awarding the bounties.

xix http://carbonvote.com/

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