KES Insights

Service-via-Software (SvS) - The Digital Engineering and Energy Services Model

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Summary

Digitization is ongoing in various industries and unlocking new potentials and benefits to them. There is also the data-driven future, which the engineering and energy industry is heading towards. This data-driven future holds distinct possibilities that would significantly advance the engineering and energy industry. Digitization is necessary to unlock this data-driven future.

In this paper we examine the service-via-software phenomenon and the role it plays in digitization of services. We present a model for the translation of services in the engineering and energy industry into its digital counterparts. We demonstrate its applicability in the case of online condition monitoring.

Finally, KadMap® – a digital solutions platform is presented. On KadMap®, remote asset integrity monitoring (R-AIM), a digital service, is presented as an instance of service digitization for the engineering and energy industry.

Keywords: Digital Service, Service-via-Software, Data-Driven Engineering, KadMap, Industry 4.0, CAST-D, big platform

Contents

Introduction – Digitization, the Silent Ongoing Revolution

There is a silent digital revolution currently ongoing. A digital version of earth is being built (see: *The Engineered Future – A Likely Preview*[4]). Digitization[5] is the theme of this revolution. The digital revolution has been going on for the better part of the last 50 years and at an accelerated rate in the last 20 years.

Digital Earth

Prior the last 20 years the digitization paradigm sort to improve businesses by using software to increase efficiency and thus value. In the last 20 years, the revolution continued and accelerated as the infrastructure and data technology advanced and is still advancing. In the latest phase of digitization, we will have new possibilities and more emerging technology added into digital earth. The engineering and energy (EE) industry is in the early phases of this revolution. This paper delves into an important paradigm of this revolution which is the creation of digital equivalents of conventional services within the EE industry.

In this publication, we explore phenomenon of service-via-software (SvS) and present a model for service digitization citing online shopping as an instance. We then proceed to examine online condition monitoring as a case study of SvS in the EE industry.

[4] http://bit.ly/EngFuturePrev-KES
[5] Digitization: is the creation of a digital copy/representation of a physical entity.

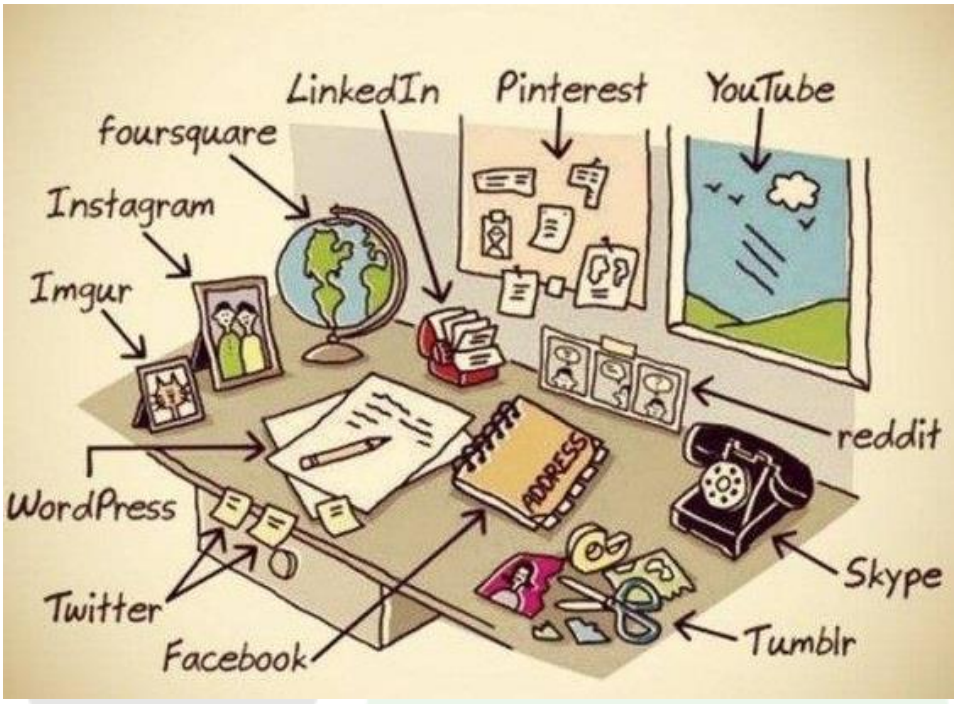
The Data-Driven Future of the Engineering and Energy Industry

In the data-driven future (again see: *The Engineered Future – A Likely Preview*[6]) we are looking to solve problems that were hitherto unsolvable by traditional empirical model-driven engineering methods with data science. The data-driven approach is already utilized in a few areas such as asset availability, reliability and generally asset integrity. Data gives us the ability to view our common everyday activities from a unique point of view – a view where we can solve problems more effectively and precisely. It is hoped that in the future several aspects of EE enterprise operations – from drilling/exploration to construction, project management etc., will also move towards this data-driven approach. The future is data-driven, not because it is trendy, but because the benefits are real. They have been witnessed over a period of time in other industries like marketing and advertisement led by massive web-based platforms.

The Digital Companions

By digital companion, we are referring to the abstracted representation of tangible and intangible nouns from our physical world into a digital space such as the world wide web. We are looking into the abstraction also, which is the intricate process and philosophy behind making a viable digital representative/companion. This representation is not just of the tangible EE nouns such as assets or physical buildings, but also intangible aspects like operations or services. This digital representation and its abstraction process and philosophy are a necessary feature in the data-driven future.

[6] http://bit.ly/EngFuturePrev-KES



Digital Representations/Companions of Various Physical Nouns (source: web)

In the illustration above we can observe how several aspects of our daily lives have been abstracted onto this digital earth – pictures, addresses/contacts, voice communication, videos, etc.

While the digitization of tangible EE nouns are challenging enough and an ongoing topic for discussion, equally tasking is the digitization of intangible EE services and operations. Guiding this challenge of digitization of EE services and operations is the coinage – Service-via-Software (SvS).

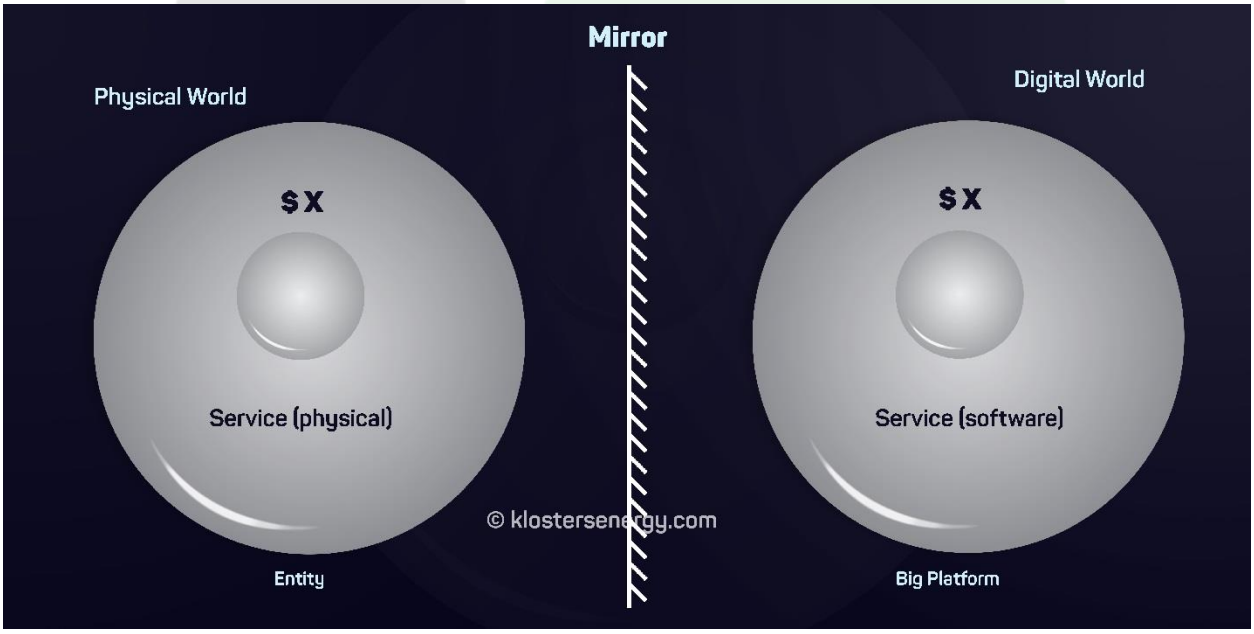
The Service-via-Software Phenomenon

We have concepts such as PaaS, DaaS, SaaS, IaaS (platform-as-a-service, data-as-a-service, software-as-a-service, infrastructure-as-a-service, respectively), etc. in information technology (IT) diction to describe and distinguish various kinds of services and even business models of the digital earth. SvS describes a distinct set of web-based applications (software) that are not for direct profit, but are digital complements/companions to services that exist, and are already being carried out in the real world. These web-based applications only serve to reflect those services in the digital world.

Examples include web applications of hotel bookings, online shopping, buying music online[7], online food orders, flight booking, taxi hailing, and online banking.

In the SvS phenomenon, the "software" serves as a digital frontend or application on which actions by a client/customer translate to real organization operations to deliver a "service". For example, when I order pizza online through an app, there are physical processes that are initiated. For each digital action initiated there is a physical reaction in the real world.

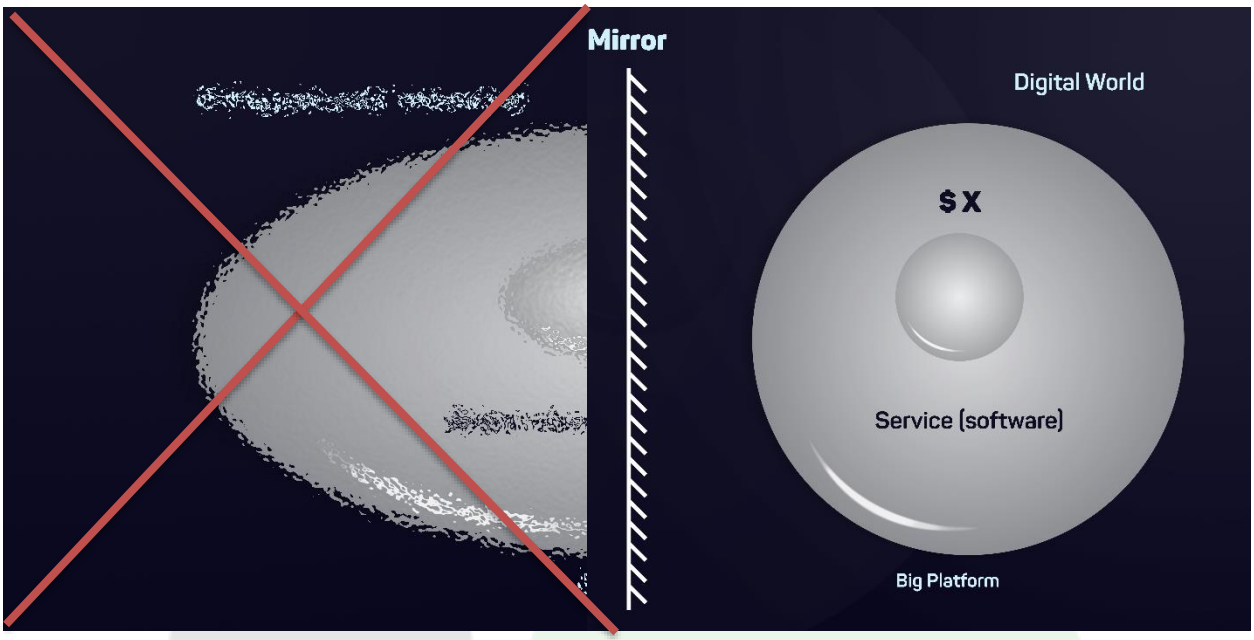
For the digital services to completely reflect the physical service condition, they must be built on coherent data conventions – which are implemented on a digital platform (see: *A Big Platform for the Engineering and Energy Enterprise – What Is It and Why Do We Need It?*[8]). This is illustrated below:



Digital Service (Software) Equivalent of Physical Service

The "entity" represents the organization where physical service is carried out. When the digital abstraction has reached the highest point, we can eliminate the physical aspect completely. This is illustrated below:

[7] This is not to be construed with paid web services like music streaming which does not exist in the real world
[8] http://bit.ly/BigPlatEEInd-KES



Elimination of Physical Service as a Result of Digital Counterpart

This is the highest form of digital abstraction/digitization – where the software service completely replaces the physical service.

In the digital future of the EE industry, we will witness three types of services:

1. Hybrid digital services
2. Fully transitioned digital services
3. Exclusively digital services

1. Hybrid Digital Services

These are digital services which do not fully reflect their physical counterparts. They contain some aspects of the physical service and perhaps some others which are not also available physically.

At the start of the digitization of the EE industry not every service will be entirely digitized at the first iteration. However, this start will involve some low-level digitization, as a means to begin the transition. Consequently, such services could be complementary and hybrid services – having

aspects done physically and others digitally. Time and technology evolution will naturally aid this category of services which will be considerable in number and scope.

2. Fully Transitioned Digital Services

These are digital services which completely reflect their physical counterparts. They contain every aspect of the physical service and perhaps some others which are not also available physically.

3. Exclusively Digital Services

Lastly, by virtue of a big platform[9] with several users in a targeted industry/with niche users, new services which build on the auspices and successes of other digital services on such platform will be developed. These services would not have a physical precedent service; they would be exclusive to the digital domain.

Big Platform is a Necessity

Service providers deliver services with reference to stipulated codes and guidelines. These codes and guidelines are usually from client companies which are mainly in line with (usually stricter than) standards from an international organization such as the international standards organization (ISO), classification societies, etc. This provides the advantage of efficiency, quality assurance, consistency for clients as well as other players in the supply chain among others.

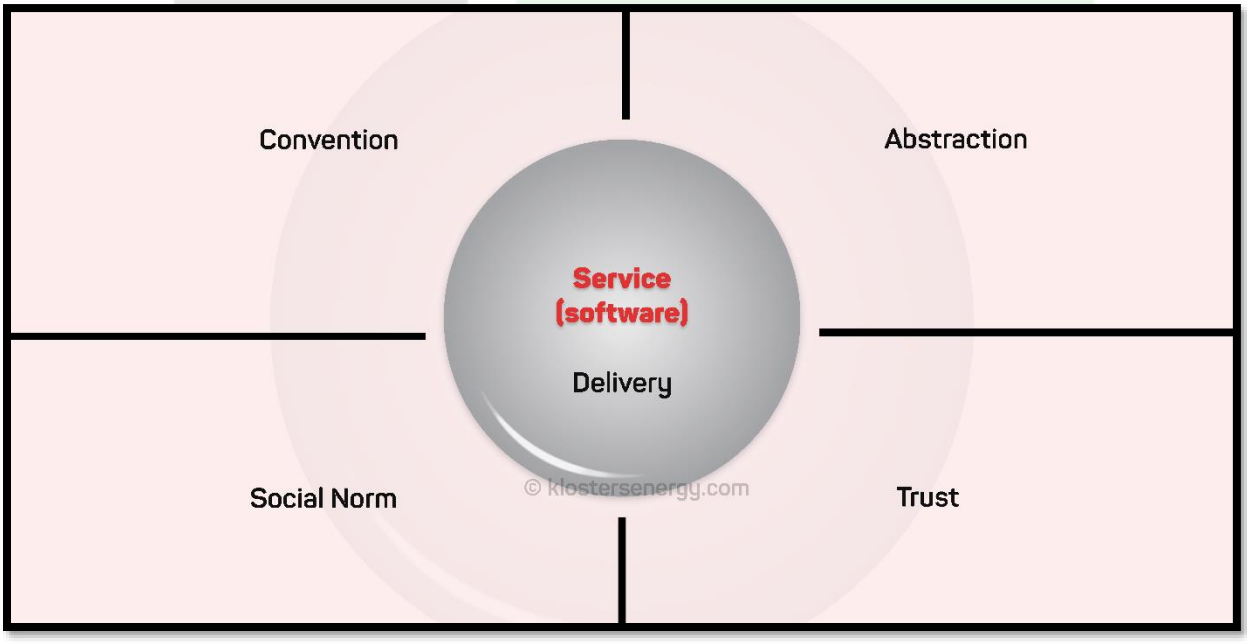
The key component of digital EE services is data. For digital companion to successfully propagate throughout the EE industry it must be consistent in data (input, format and storage) such that multiple service providers can work with the same data. This is one of the key factors for the sovereignty of data over software (see: *The Engineered Future – A Likely Preview*[10]). The consistent data has to be hosted on a standard industry wide software platform in similar manner which large

[9] http://bit.ly/BigPlatEEInd-KES
[10] http://bit.ly/EngFuturePrev-KES

standards organization like ISO and classification societies host, develop and update standards for the industry. (see: *A Big Platform for the Engineering and Energy Enterprise – What Is It and Why Do We Need It?*[11]).

CAST-D Analyser Model

We present one of our digitization processes we utilize at KES[12] – the CAST-D analyser model. CAST-D is an acronym for convention, abstraction, social norm, trust and delivery. It is a framework for digitizing services from inception to finished software. Each acronym represents a requirement for successful digitization. For each requirement, there are key actors/factors and critical acceptance thresholds all of which are critical in determining the successful digitization of a service to any degree.



SvS CAST-D Model

Key Actors/Factors:

[11] http://bit.ly/BigPlatEEInd-KES
[12] Klosters Energy Services Limited

This refers to the stakeholders, events, entities or phenomena pertaining to a CAST-D requirement which must be satisfactorily addressed.

Critical Acceptance Threshold:

This is the degree (measured in percentage estimates) to which the key actors/factors must be addressed/satisfied to further ensure the success of a CAST-D module.

1. Convention:

This is the convention requirement aspect of service digitization. There needs to be a clear, coherent, agreed and understood convention of a digital service. The convention contains all related data which will be extracted for abstraction. Key aspects of convention include:

- User identification: Who are the target users (TUs)?
- Service description: How is the service offered physically?
- Data transactions: What are the physical data transactions surrounding the service?
- Technical nomenclature: What are the technical nomenclatures utilized in the service?
- Service culture: What is the usual service culture?
- User comprehension: Does that target understand this service completely?

Key factors/actors for Convention: These include target users, industry professionals, professional societies and stakeholders

Critical Acceptance Threshold for Convention: 100% understood convention of existing physical service by key factors/actors.

2. Abstraction:

This is the abstraction requirement aspect for service digitization. It involves every aspect of service data abstraction (data extracted from the Convention requirement of CAST-D), representation, presentation (especially visual via user interfaces) and experiences. This takes time and needs to go through a number of iterations and version updates to reach the ideal. Key aspects of abstraction include:

- Method: How is the service offered digitally?
- Capacity/capability: Are the available technologies/infrastructure in place to give the complete/total service experience?
- Abstraction completeness: Are the physical data transactions and service culture from the convention completely replicated?
- Presentation: Can the physical senses be tricked into believing that they are experiencing the same service as the physical?
- Technology adoption: How much of the prevalent technology conventions from other industries/sectors can/does it adopt?
- Service augmentation: How much "new" needs to be introduced to make experience complete in the digital service?
- Training/learning curve: How much of it needs to be learned/requires training?

Key factors/actors for Abstraction: Target users (TUs)

Critical acceptance threshold for Abstraction: 30% acceptance by TUs. This is so because no service can attain 100% abstraction at the first design iteration, for everyone, and even many years after. However, while *time factor* should allow for users to accept the digital service, the providers must adjust rapidly to the user needs/behaviour. Peer education will take place when the remaining CAST-D requirements are also met.

3. Social Norm:

This is the social requirement aspect for service digitization. The digitized services need to be accepted as a social norm by TUs. Manifestation of this acceptance results in language accommodation of activities on the digital services such as 'share', 'tweet', 'like', 'subscribe', 'follow', etc. This is also a good indicator of commercial success. Aspects of the social norm requirement include:

- Awareness: How many of the TUs know it?
- User niche: What channels use it consistently (e.g. schools, industries etc.)?

- Inherent need to learn/adopt/use: Are there compelling enough demands (especially from user niche) that make it almost mandatory for TUs to learn and use it?
- Learning opportunity: Is it readily available by trainers, colleges/universities?
- Geography and linguistic diversity: Is the digital service available in several locations/languages?
- Several providers: are there enough alternatives that further familiarity with TUs/is it replicable?

Key factors/actors for Social Norm: marketing/awareness

Critical acceptance threshold for Social Norm: Adoption by the most visible and influential 1% of the target market

4. Trust:

As the name suggests, this is the trust requirement aspect for service digitization. Trust is what lets the TU completely rely on it even when physical alternative is present. Aspects of the trust requirement include:

- Brands: How well known is/are the various brand(s) (digital service providers)?
- Brand track records: Do they have a track record?
- Brand track record witness: Who can attest to the efficacy of their solution?
- Brand QA/QC regulation: Does the service provider need certification/endorsement by any recognisable body?
- Service threats: What threats are there to adopting/utilizing the service and how critical (if any) are these threats to the integrity[13] of the user?
- Service threats minimization: Can these threats (if any) be minimized?
- Threat minimization cost: What is the cost of minimizing the threat(s) to the user?

Key factors/actors for Trust: medium, assistive technologies, certifying bodies, track record, brand, user behaviour

Critical acceptance threshold for Trust: 99% satisfaction of key actors/factors.

[13] Integrity includes security and privacy

5. Delivery:

This is the delivery requirement aspect for service digitization. The products/outcomes of the service must be completely similar to the physical service without diminish. There is a singular aspect of this requirement:

- Is the product/outcome of the service consistently same as the physical?

Key factors/actors for Delivery: service outcome

Critical acceptance threshold for Delivery: 100% similarity of product/outcome of the digital service to that of the physical service

Practical Application of CAST-D Analyser Model to Real Instances of SvS

The SvS phenomenon has been demonstrated profusely on the big platform that is the world wide web (www). On this platform, web browsers, web hosts, database providers, access providers, are some of the factors/actors propagating and maintaining consistent data conventions. Over the www we have several cases that could be examined ranging from online gaming, online shopping, online music sales, Online banking, online gambling, online dating, to online work outsourcing, etc.

We will consider the case of online shopping in this paper.

Online Shopping

Online shopping has a long history[14], emerging in the 1960's as IBM's online transaction processing (OLTP) via links to a large IBM mainframe computer, and evolving in Michael Aldrich's real-time transaction processing computer via a domestic telephone line in 1979. Online shopping as we know it today, took off with the further advancement of the WWW specifically in 1994. It grew from a simple utility to showcase products (advertisement) to actual online shopping transaction due to the development of interactive web pages and secure transmissions. Some of the early pioneers include

[14] Source: Wiki

NetMarket (1994), Amazon and eBay, (both 1995). We will now analyse online shopping using the CAST-D model:

Module	Scrutiny	Remarks
Convention	**User identification:** *Who are the target users?*	The general public
	Service description: *How is the service offered physically?*	Business entity owns a physical location which stocks goods that customers come to buy
	Data transactions: *What are the physical data transactions surrounding the service?*	Money exchange medium (cash or electronic), buyer, seller, date of transaction, receipts, quantity, item, trolley, cart, etc.
	Technical nomenclature: *What are the technical nomenclatures utilized in the service?*	Buy, sell, refund, check out, stock, counter, shelves, price, loyalty rewards, customer, receipt, gift cards, coupons, etc.
	Service culture: *What is the usual service culture?*	Pay before carrying goods, know the price first, pay stated price, etc.
	User comprehension: *Do the target understand this service completely?*	Been around since the dawn of time, it is very well understood
	Current Acceptance Level	100% understood by target users
Abstraction	**Method:** *How is the service offered digitally?*	A virtual representation of a shop is created on a website and hosted over the internet. The website displays various goods and has well-defined features to complete a business transaction. After a transaction is complete the online customer receives their item(s) physically.
	Capacity/capability: Are the available technologies/infrastructure in place to give the complete/total service experience?	The internet, the WWW, computers, web browsers, web payment platforms, email providers, telecommunication carriers, web developers etc. are the required technologies that make online shopping possible
	Abstraction completeness: *Are the physical data transactions and service culture from the convention completely replicated?*	Yes, the physical data like money exchange medium (electronic), buyer, seller, date of transaction, receipts, quantity, item, cart, etc. are all present in online shopping The culture is also replicated. It is manifested in features such as, ability to view items before purchase, price is displayed, there is a basket feature, checkout feature, etc.
	Presentation: *Can the physical senses be tricked into believing that they are experiencing the same service as the physical?*	Web developers have captured and recreated the experience of what goes into the ideal online shopping website with several businesses/brands implementing it successfully.
	Technology adoption: *How much of the prevalent technology conventions from other industries/sectors does/can it adopt?*	Online shopping derives all its appearances from a plethora of web technologies and it is still evolving

	Service augmentation: *How much "new" needs to be introduced to make experience complete in the digital service?*	Yes, there are. Features such as wishlist, ratings, seller verification, suggestions, etc. are digital augmentations that exist only in the digital world (online).
	Training/learning curve: *How much of it needs to be learned/requires training?*	Online shopping platforms and technology evolved with web users' online behaviour and continually does so, minimally making any new introductions. As a result, online customers are able to even use new online platforms intuitively.
	Current Acceptance Level	100%. It took some time for web designers and developers to reach the current design iteration, where we can say that the concept presentation of online shopping is mature.
Social norm	**Awareness:** *How many of the TUs know it?*	Online shopping has been around from the time of the global launch of the world wide web (1999). Pioneers and big brand names such as eBay, Amazon, and later Alibaba all helped to propagate the awareness of online shopping.
	User niche: *What channels use it consistently (e.g. schools, industries etc.)?*	Pretty much the general population utilize online shopping in buying. Some online platforms feature third party sellers (usually SMEs) who also rely on such platform of added sales.
	Inherent need to learn/adopt/use: *Are there compelling enough demands (especially from user niche) that make it almost mandatory for TUs to learn and use it?*	It is very beneficial, to both buyers and sellers. Two of the key benefits are (1) that it makes for great convenience and variety for the buyer and (2) a large market for the seller.
	Learning opportunity: *Is it readily available by trainers, colleges/universities?*	There are tons of courses and material from platform owners and third parties alike to users who may want to go advanced in aspects other than pure shopping. (e.g. sellers, advertisers)
	Geography and linguistic diversity: *Is the digital service available in several locations/languages?*	Yes, firstly over half the planet's population is on the web. Online shopping is prevalent across countries and languages across the world
	Several providers: *Are there enough alternatives that further familiarity with TUs/is it replicable?*	Online shopping is solidly established in the norm of web users with several big players (Amazon, eBay, Alibaba, etc.) performing well in the market and providing this valued service for web users
	Current Acceptance Level	100% Accepted as a social norm
Trust	**Brands:** *How well known is/are the various brand(s) (service providers)?*	Online shopping is very well-known the world over and features several big players such as Amazon, Alibaba, eBay, etc. and in the USA, there are over 3.8 million online shopping websites[15].
	Brand track records: *Do they have a track record?*	The model has been demonstrated by the big players to prove that it does work very well through the billions of items sold online.
	Brand track record witness: *Who can attest to the efficacy of their solution?*	The user base (online buyers) is proof that the model works. Nearly 1.92 billion people shop online[13], about a quarter of the world's population

[15] TechJury

	Brand QA/QC regulation: *Does the service provider need certification/endorsement by any recognisable body?*	Not applicable, just as physical shops do not require any (except in the case of special items) besides conformance to extant legal codes such as consumer protection acts (CPA) stipulated by governments of their residence.
	Service threats: *What threats are there to adopting/utilizing the service and how critical (if any) are these threats to the integrity of the user?*	Security (website phishing, scams, electronic payment security, etc), non-receipt of goods paid for, goods differing from descriptions on websites, etc. These are very serious concerns to the user
	Service threats minimization: *Can these threats (if any) be minimized?*	Over the years these concerns have been significantly minimized. Online transactions are an everyday reality in today's world with incidents becoming very isolated due to constantly security evolution of both online shopping platforms and online payment processers. Also, there are fairly conventional means of handling seller-buyer disputes with considerable level of success
	Threat minimization cost: *What is the cost of minimizing the threat(s) to the user?*	Very minimal, antivirus (a lot of good protection for free with antispyware), and personal habits such as general caution with sensitive details are enough. These measures do not alter the user's life/habits.
	Current Acceptance Level	100%. There is a great and increasing amount of trust in online shopping as user figures are set to further increase.
Delivery	**Identical service delivery:** *Is the product/outcome of the service consistently same as the physical?*	The items delivered by the online shopping experience is the same as that from a physical store (bar cases of delivery incidents)
	Current Acceptance Level	100%, This has been largely tested by the huge volume of transactions that have been taking place since inception till date

CAST-D analysis of online shopping

Case Study: Online Condition Monitoring of EE Assets

Condition monitoring is the ongoing maintenance organizational procedure of determining the condition of an asset by monitoring specific operating parameters of the equipment in order to detect characteristic deviations which are indicative of impending failure.

It usually involves surveillance of facilities usually by staff of the asset owning company by physically perform site walkarounds, spot checks at designated times, often frequently and over defined areas.

Over the decades evolution of instrumentation and sensor detection led to the development of control panels with the capacity to monitor sensor readings and indicate via alarms systems, hazardous operating parameters. These control panels where monitored remotely from the site of the operations within a control room. This is also very suitable for remotely unmanned facilities. Today this form of monitoring has been ported to other platforms such as tablet and mobile to enable facility operators monitor activities in the plant from distant non-official locations.

This forms a good case study as it involves a service which was initially carried out physically and is currently being digitized.

Online Condition Monitoring: A CAST-D Analysis

CAST-D Requirement	**Scrutiny**	**Online Condition Monitoring**
Convention	**User identification:** *Who are the target users (TUs)?*	EE Asset owning enterprises staff; particularly the facility engineering, operations and maintenance departments and control room staff
	Service description: *How is the service offered physically?*	This is physical condition monitoring where delegated staff physically perform walkarounds, assessing the condition of asset equipment with specific routine check procedures, condition monitoring, spot checks. Also, there is periodical reporting.
	Data transactions: *What are the physical data transactions surrounding the service?*	Alerts, operators, facility, components (indicators, pipes, etc.), alarms, valves, detectors, signal, levels, safety etc.

	Technical nomenclature: *What are the technical nomenclatures utilized in the service?*	Incident reporting, diagnostics, hazard awareness, safety, operations, piping and instrumentation diagram, piping and flow diagrams.
	Service culture: *What is the usual service culture?*	Very frequent surveillance, and reporting. Constant update for the operation and maintenance teams
	User comprehension: *Does the target user understand this service completely?*	Target users understand. This is a very established maintenance practice in the EE industry.
	Current Acceptance Level	100%
Abstraction	**Method:** *How is the service offered digitally?*	Sensors on facility (usually by facility instrumentation OEMs) which relay various facility system/subsystem/component indicator data to control system at the control room. Data is also increasingly transmitted over the internet to enable monitoring and actuation from mobile devices.
	Capacity/capability: *Are the available technologies/infrastructure in place to give the complete/total service experience?*	Yes, some of the technologies/infrastructure include sensors, actuators, networking, internet, computers, email providers, telecommunication carriers, software developers, etc.
	Abstraction completeness: *Are the physical data transactions and service culture from the convention completely replicated?*	Not 100% replicated, since instrumentation still is not advanced enough to completely replace human inspection for most cases. The physical data transactions like reports, operators, facility, components (indicators, pipes, etc.), alarms, valves, detectors, signal, levels, etc. are all present in online monitoring The culture is also replicated. There is live monitoring with constant update for operation and maintenance teams.
	Presentation: *Can the physical senses be tricked into believing that they are experiencing the same service as the physical?*	Vivid graphical representations, use of software already on asset control room panels, in addition to the symbols/representations imbibed from trainings are sufficient to give the good impression of the facility operations and processes.
	Technology adoption: *How much of the prevalent technology conventions from other industries/sectors can/does it adopt?*	EE symbols, representations, culture are pretty detailed and traditional. The TUs expect these same conventions repeated in the digital service. There is influence from other technologies; an example being AI (artificial intelligence) and web technology adoption.
	Service augmentation: *How much "new" needs to be introduced to make experience complete in the digital service?*	As much as is necessary. Trainings are pretty standard and regular, and as such any new technology or features are expected to be imbibed in the training process.
	Training/learning curve: *How much of it needs to be learned/requires training?*	Everything requires training and refresher courses periodically for operation due to the safety implications involved.
	Current Acceptance Level	100%
Social norm	**Awareness:**	The service exists. Big instrumentation players such as GE,

	How many of the target users know it?	Siemens, Yokogawa, Emerson Process, etc. provides means of observations online for the EE clients to view their assets
	User niche: *What channels use it consistently (schools, industries, etc.)?*	Online monitoring is used by the EE asset owners and instrumentation OEMs and third-party service providers.
	Inherent need to learn/adopt/use: *Are there compelling enough demands (especially from user niche) that make it almost mandatory for TUs to learn and use it?*	It is very beneficial to both EE asset owners. Top of the benefit list are, that it makes for great convenience and remote access even outside of the asset/enterprise premises
	Learning opportunity: *Is it readily available by trainers, colleges/universities?*	There are tons of courses and material from instrumentation OEMs and certified third parties alike to users.
	Geography and linguistic diversity: *Is the digital service available in several locations/languages?*	Online monitoring service variants are provided worldwide and in different languages
	Several providers: *Are there enough alternatives that further familiarity with TUs/is it replicable?*	Online monitoring is solidly established in the norm of EE enterprises with several big players (GE, Siemens, Yokogawa, Emerson Process, etc.) performing well in the market for providing this valued service
	Current Acceptance Level	100% Accepted as a social norm even though patronage may vary
Trust	**Brands:** *How well known is/are the various brand(s) (digital service providers)?*	There are several known brands. They have been around since the 1970's and well propagated throughout the EE industry.
	Brand track records: *Do they have a track record?*	These companies have excellent track records as evidenced by the industry coverage they have.
	Brand track record witness: *Who can attest to the efficacy of their solution?*	Top EE asset owners utilize this service across the entire EE industry
	Brand QA/QC regulation: *Does the service provider need certification/endorsement by any recognisable body?*	A good number of these organizations providing this service are firstly engineering companies who then provide the digital counterpart service. As regular engineering outfits they have their services/products certified by recognized certifying bodies. The digital services may also be certified as part of their physical services
	Service threats: *What threats are there to adopting/utilizing the service and how critical (if any) are these threats to the integrity of the user?*	Security threats: This is very serious concerns to the EE asset owner especially with the integration of control over remote (web-based) access applications The threat is very critical to asset owners as they risk system compromise which could lead to catastrophic events and thus damage company reputation.
	Service threats minimization: *Can these threats (if any) be minimized?*	Yes. For instance the EE asset owner could utilize a closed network (which has very remote chance of compromise)

	Threat minimization cost: *What is the cost of minimizing the threat(s) to the user?*	Very minimal if at all since it does not alter the user's overall enterprise significantly.
	Current Acceptance Level	100%
Delivery	**Identical service delivery:** *Is the product/outcome of the service consistently same as the physical?*	Not completely, it is a good complementary service. It is impeded by technological limits on instrumentation.
	Current Acceptance Level	Definitely not 100%, maybe 50%

CAST-D analysis of online condition monitoring

KadMap®

The name "KadMap" is a coinage for the holistic digital framework and infrastructure to deliver digital asset solutions. It is developed and maintained by Klosters Energy Services (KES). Embedded in the name KadMap®, are acronyms for keywords such as asset, data, management and platform.

KadMap®

KadMap®

KadMap® hosts a range of digital solutions to myriad challenges affecting engineering and energy (EE) assets and operations.

The scope of KadMap® encompasses several assets and operations of the EE industry. For more on KadMap® click here.

Remote Asset Integrity Monitoring (R-AIM) - A Digital Service on KadMap®

In the paper *Interfacing Artificial Intelligence, Risk Management and Asset Integrity*[16], we talked about artificial intelligence (AI), risk management (RM) and asset integrity. We looked at the strengths of

[16] http://bit.ly/IntegAI-RM-AIM-KES

both AI and RM and showed how they would work together in a defined framework to deliver the goal of optimal production.

Remote asset integrity monitoring (R-AIM) is a solution based on the hybrid (RM-AI) framework and visualized and operated on KadMap® with the EE enterprise in focus.

R-AIM is a digital counterpart of risk-based inspection (RBI). RBI is an optimal maintenance method used to access risk (probability and consequence) of failure in EE assets with the intent to optimize inspection intervals while keeping identified risks (especially health, safety and environment (HSE)) as low as reasonably practicable (ALARP) with cost effective strategies.

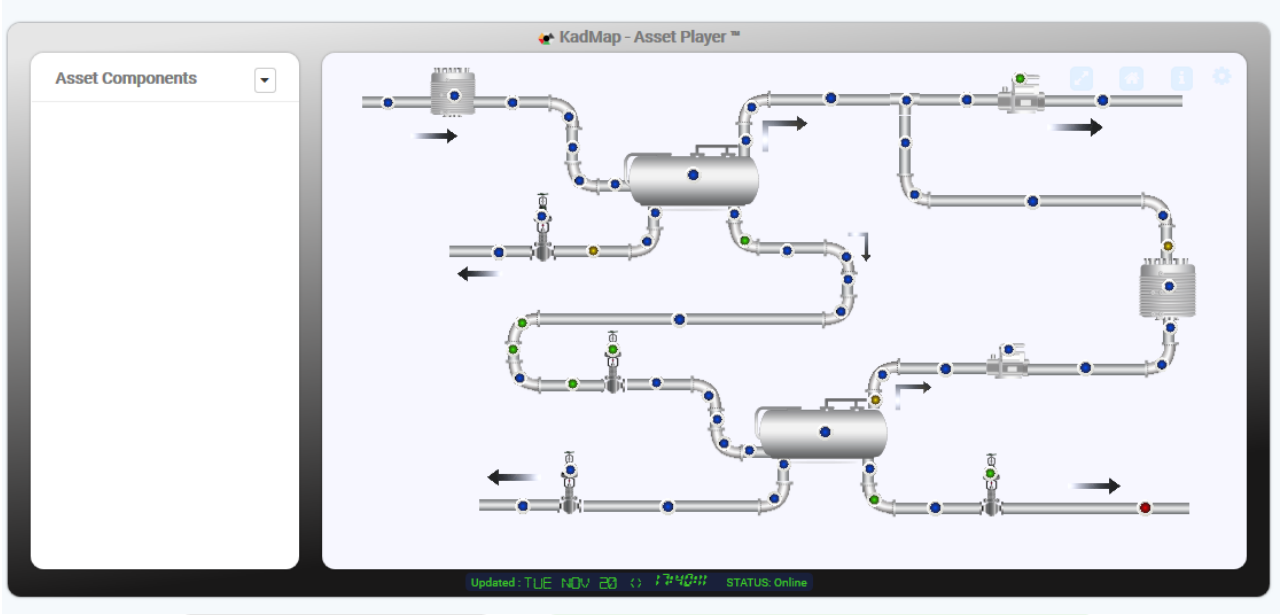
R-AIM is by our definition, is a hybrid service which complements RBI with real-time data reporting, remote surveillance, enterprise view and interactivity, round the clock access to information, industrial collaboration, managerial oversight and decision making among others. RBI becomes further improved with the digital companion service R-AIM on KadMap®.

R-AIM can be accessed and visualized in real-time in KadMap Asset Player™.

KES develops and maintains KadMap® Asset Player™ - a KadMap® application, which processes and interprets asset data into DTTF[17]-based integrity readings which managers and decision makers can use to:

1. Significantly enhance their asset integrity management strategy
2. Improve their profitability
3. Improve their safety
4. Increase the lifespan and value of their asset.

[17] DTTF (dynamic time to failure) is the time it takes for an asset's integrity to degrade completely to failure. It is a measure of a system's (asset here) response to environmental and production dynamic load conditions, as a predictor of time to failure, given those inherent conditions.



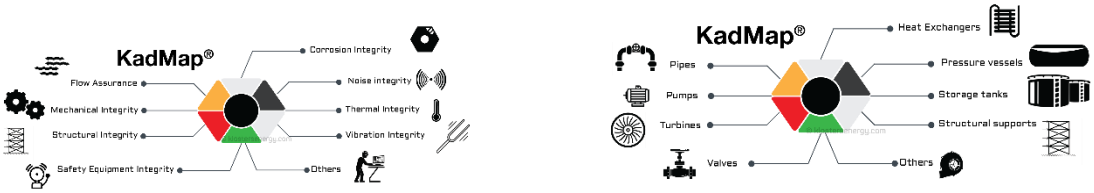
KadMap® Asset Player™ Screenshot (2D)

KadMap® Asset Player™ displays a 2D digitized version of an asset. There are bulb indicators on various components/subsystems of assets. The bulb indicators on the displayed sample asset show the state of each component/subsystem via specific blinking colourations with their meaning as follows:

DTTF Category	Colour Code
Ideal (Best possible)	
Normal/Functional	
Critical	
Failure imminent	
Offline	

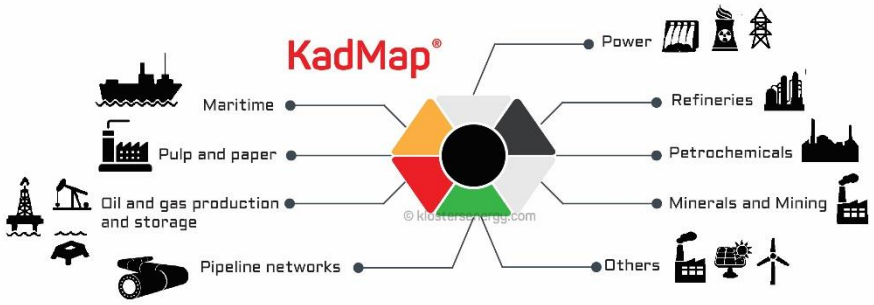
KadMap® Asset Player™ component status legend

R-AIM can be deployed for various operational concerns (corrosion, vibration, flow assurance, etc.) among various asset components (pipes, valves, pumps, etc.) across several assets and industries.



R-AIM for Various Operational Concerns and Asset Components

R-AIM will be available to production and processing companies from downstream petrochemical processing to upstream subsea to power.



R-AIM for Various EE Industries

KadMap® Asset Player™ can also be assessed remotely on several devices and operating systems.

R-AIM Remote Accessibility

R-AIM is a clear instance of the SvS. It is made possible through the use of digital data.

Conclusion

There is a silent ongoing revolution creating a digital earth. We have looked at the data-driven future of EE industry which is on the horizon. This data-driven future involves creating digital companions not just tangible entities but also intangible services. This future will require engineering firms will need to start producing the e-component of their businesses. It is going to spurn new services and advance already existing services. We have presented the CAST-D analyser model which we at KES utilize in digitization of services. We demonstrated the applicability on the case of online condition monitoring.

KadMap® has been presented as a means to implement the digital services in the EE industry. R-AIM is an instance of a hybrid digital service. KadMap® is currently in development. Its development strategy along with release dates have been outlined.

Reviewers

1. Chukwunyelu Chukwuka
2. Chidiebere Nwaoha

Review Verification ID Link

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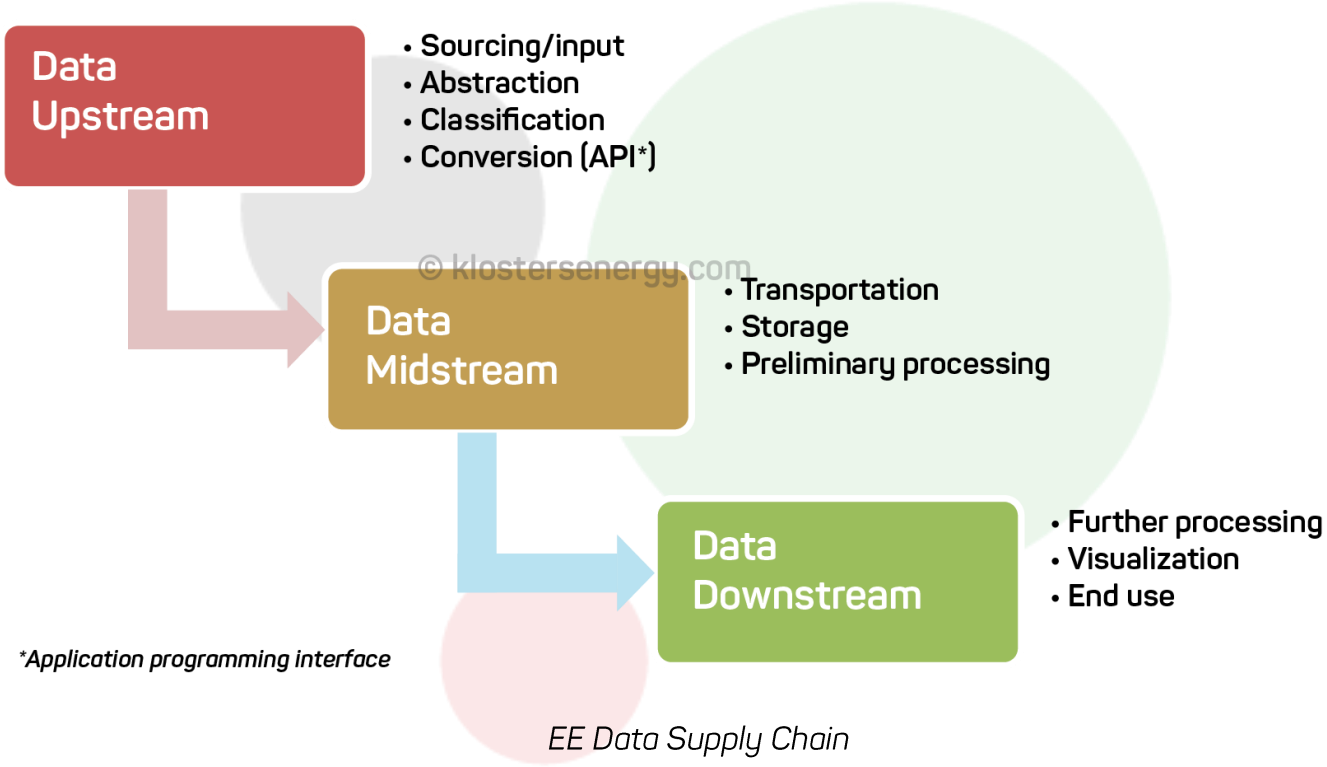
http://bit.ly/SvSDigitEngMod-KES

Annex

KadMap®

KadMap® is a very data-oriented solutions platform with particular focus on digitization and data abstraction, specializing in the upstream (data sourcing/input, abstraction, classification and conversion) to the midstream (transportation and storage of data, including preliminary processing), to the downstream (further processing, visualization and end use) phases of data.



EE Data Supply Chain

KadMap® is an umbrella for all the technology involved from one end to the other in the EE data supply chain featuring both hardware and software making KadMap® the world's first of its kind end-to-end digital solutions platform.

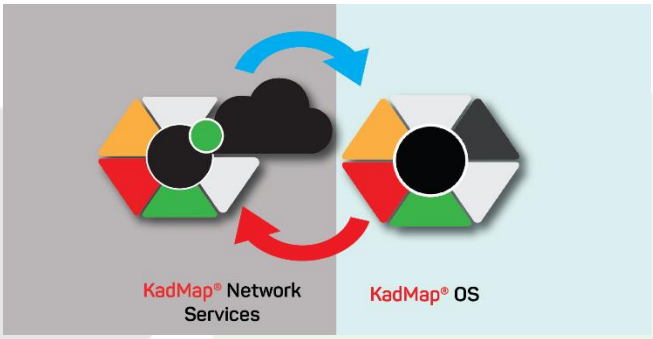
The end-to-end integrated scope of KadMap® is a huge challenge which KES has been progressively addressing since 2007. KES' strategy has been to utilize a project-based approach by creating and executing an integrated project dubbed "KadMap® Development Project", with this challenge as the goal, and each project deliverable a milestone towards addressing the challenge.

Two deliverables are of particular importance in the project:

1. KadMap® OS

2. KadMap® Network Services (KNS)

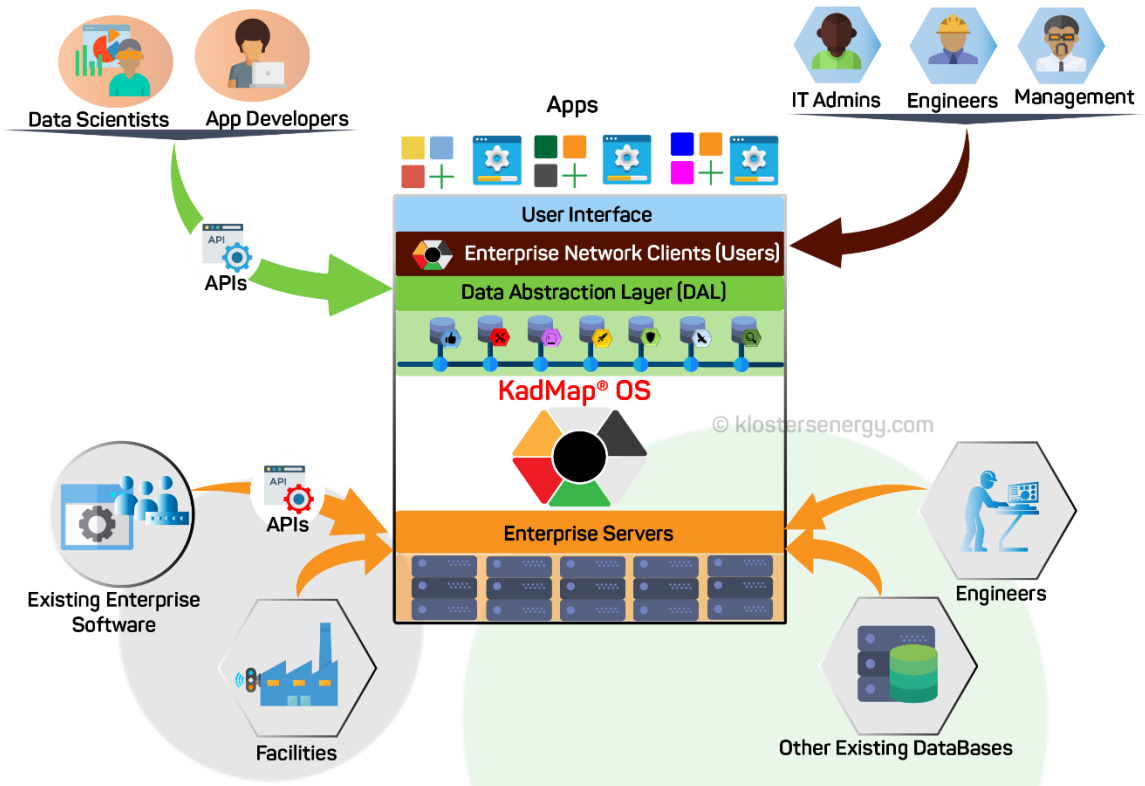
KadMap® OS and KNS both form the base infrastructure required to deliver the entire scope of KadMap®.



KadMap® OS and KNS – the base infrastructure

KadMap® Operating System

KadMap® OS (operating system) is a multi-client (server-based), multi-network, data-oriented operating system developed with the energy and engineering (EE) enterprise and operations in focus. Its architecture was developed with the inherent needs, infrastructure configuration and security concerns unique to the EE enterprise.



KadMap OS Architecture

KadMap® OS' philosophy and operations centres around data - its transmission, storage, security, visualization, access, etc. and thus features a heavy emphasis on data technology.

There are two main sides/components of KadMap® OS:

1. Client side (Network Client) – Which is for data input, organization, manipulation and rendering of data and application instances. It is installed on the local machines utilized by staff in the EE enterprise.
2. Server side (Network OS) – Which is for local hosting of applications, network administration and storage of data within the EE enterprise. It is also the gateway to KNS which delivers a range of critical functions. It is installed on the main server in the EE enterprise.

KadMap® OS Components (Enterprise Edition)

The network OS on the server side of KadMap® OS holds the data abstraction layer (DAL) which is a collection of KadMap® data libraries and APIs.

The DAL provides a common programmable interface for the development of apps for EE assets and operations.

The DAL is a comprehensive and robust deliverable required to fulfil the fast solution development potential of KadMap®. The DAL would facilitate fast development of applications capable of complex data manipulations/computations and foster the development of light utility apps with very specialized functions for the EE industry.

Part of the upstream aspect of KadMap® is executed in KadMap® OS as it provides means of data input from EE assets, employees and data sourcing from other existing software/databases.

There are several essential enterprise-wide software utilized in EE enterprises. In order to enable the enterprise continue utilizing these software, it is essential that KadMap® OS is collocated (installed) alongside these software. KadMap® OS is designed to be deployed alongside an existing OS while optimizing hardware usage on the machine (server and network client machines) with no conflict.

The industrial internet of things (IIoT[18]) interfacing is also enhanced and facilitated as KadMap® OS provides interface with sensor data from EE assets for several critical applications, analyses or other purposes (e.g. asset integrity).

The client side (network client) KadMap® provides for data manipulation and visualization. These of themselves are done by apps which are hosted on the server side (from KNS, precisely KadMap® App Store) and made available networkwide via the network client. The network client also enables remote collaboration on an industrial scale over given operations.

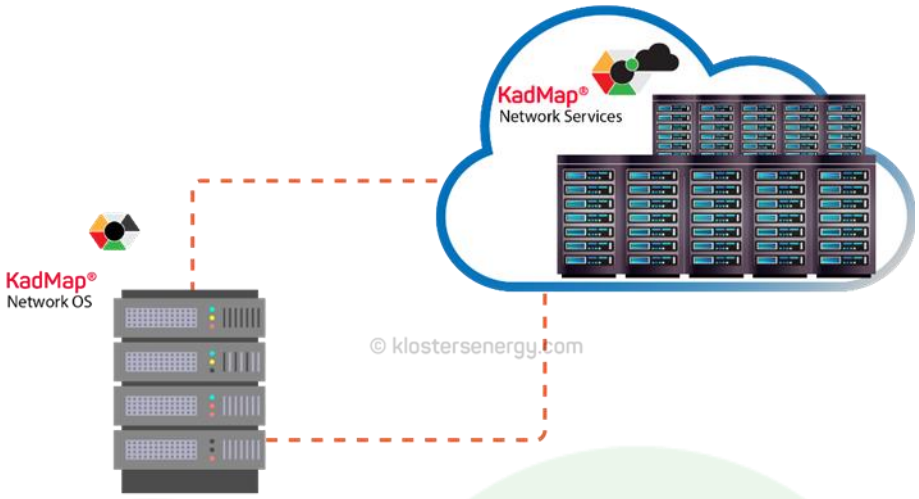
KadMap® OS architecture very importantly, allows for a high level of security and privacy whilst delivering significant benefits to the EE enterprise.

KadMap® Network Services (KNS)

KNS is a distinct network of servers and supercomputers storing and processing data from authenticated and KadMap® OS installed EE networks. Clients privacy and security is paramount and therefore their permission (via contracts) is required and their data is collected anonymously (preserving privacy).

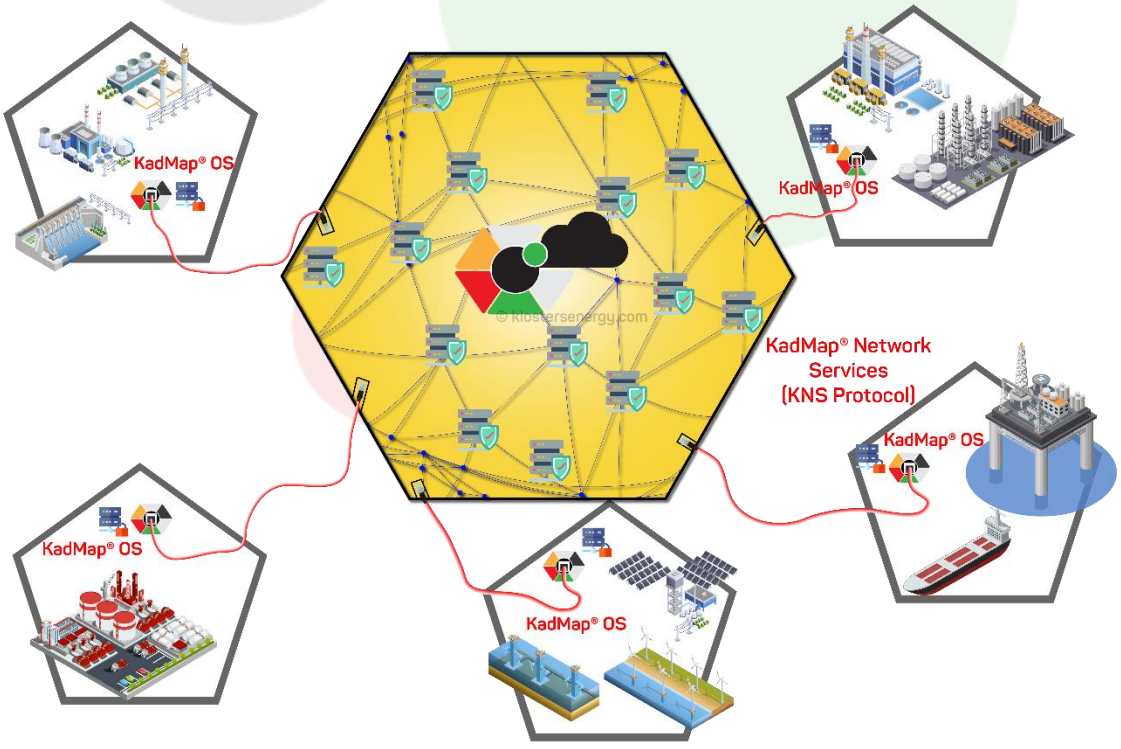
KNS also serves as machine nexus (see: *The Engineered Future – A Likely Preview*[19]) by storing data in a way that is machine readable and programmable without human interference.

[18] The industrial internet of things (IIoT) refers to interconnected sensors, instruments, and other devices networked together with computers' industrial applications, including manufacturing and energy management. (*Wiki*)
[19] http://bit.ly/EngFuturePrev-KES



KadMap® OS – KNS interface

The KadMap® OS powered machine of the EE enterprise and EE asset interact with KNS remotely and without human intervention.



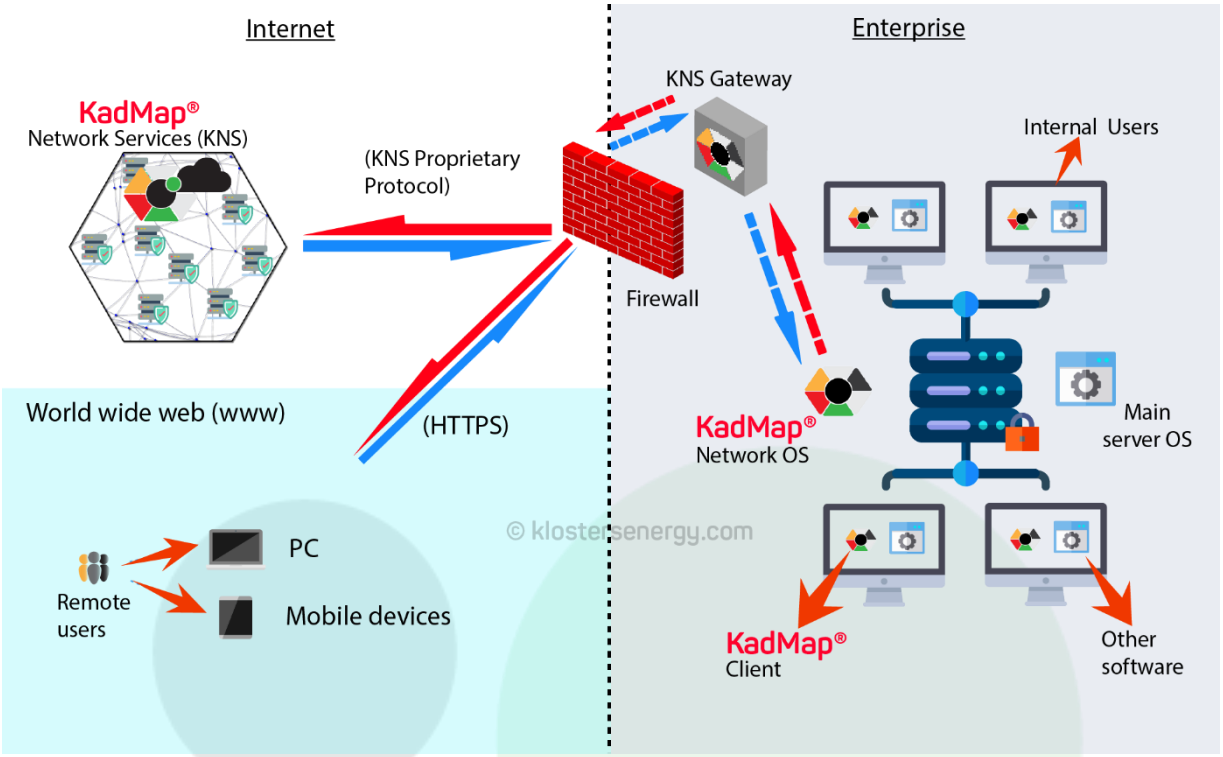
KNS – IIoT resources

The KNS provides an IIoT resource rich environment with high security, privacy and interface enabling developers create highly beneficial applications and enabling data scientists carry out in-depth analyses from feedbacks (live and archived) from EE asset sensors and devices.

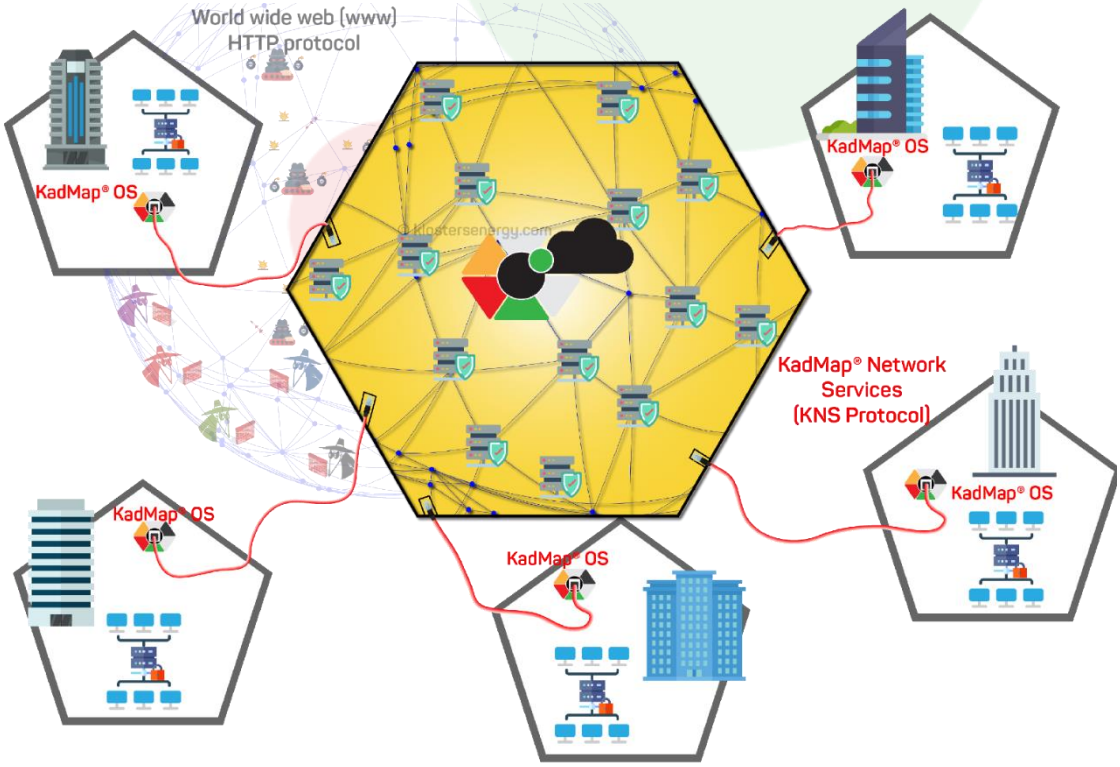
With KNS the EE industry will have a massive niche in cyberspace which is completely exclusive and accessible only by KadMap® authenticated EE enterprises. The hardware (supercomputers and high data storage servers) are high performance machines designed to deliver the heavy machine resources that are required to undertake high precision data analysis and calculations undertaken in the EE industry. The KNS utilizes a highly secure proprietary protocol (different from that used to access the World Wide Web (www) (http)) optimized for data operations which also contributes to KNS' robust security profile.

The KNS can be accessed only via a KadMap® network. Access is monitored and logged. KadMap® applications are also catalogued on the KNS after detailed security and QAQC checks in order to keep clients maximally protected at all times.

The data exchanges, remote collaborations and network access are also highly monitored and logged. Corporate espionage, security threats and malicious programs/wares are greatly minimized if not completely eliminated.



KadMap® OS – KNS Enterprise Architecture



KNS – A Trusted Collaboration Network

For more in-depth insight on KadMap® OS and KNS, see: *A Big Platform for the Engineering and Energy Enterprise – What Is It and Why Do We Need It?*[20].

The KadMap® Development Project

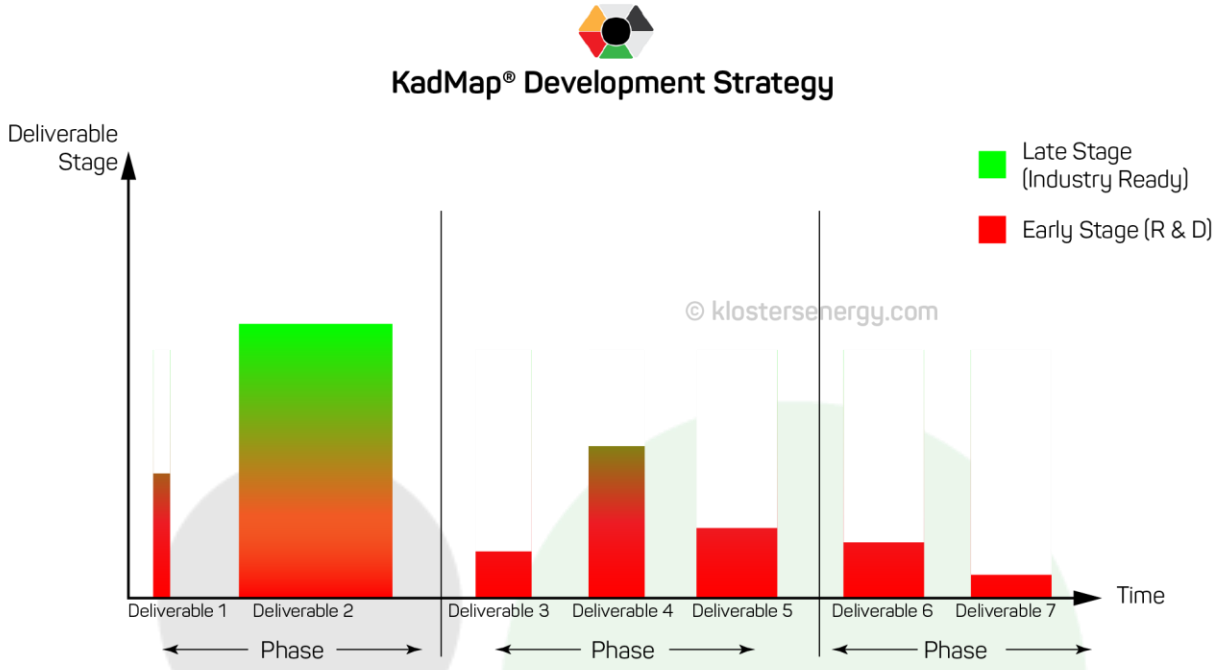
The end-to-end integrated scope of KadMap® is a huge challenge. KES' strategy to surmount this challenge has been the adoption of a project-based approach. This involved the creation of an integrated project dubbed "KadMap® Development Project" which is currently in execution. The goal of this project is to surmount the challenges inherent in the end-to-end scope of KadMap®. Each subsequent project deliverable is identified and configured as a milestone towards addressing the challenges.

Thus, the KadMap® Development Project is an ongoing project, outputting multiple deliverables in form of digital solutions and updates to KadMap®.

Each deliverable in this project is realized by following stipulated stages of activities from research to testing, verification, QAQC, industry engagements, etc. among others in a systematic and efficient manner tailored for the EE industry.

Furthermore, the project is split into phases which may overlap in time. The phases have generally specified goals while each deliverable is a push towards the specified phase goal.

[20] http://bit.ly/BigPlatEEInd-KES



KadMap® Development Strategy

The deliverables are well incubated (and usually developed concurrently) sometimes for several years at a time in order to attain seamless integration, interface and compatibility between all developed solutions.

There are 9 stages in total required for the incubation and development of a KadMap® deliverable from inception to industry:

1. *Technology gap research*	2. *Technology R&D*[21] *including validation/verification of findings*	3. *Early market research*
4. *Solution integration/packaging into distinct product for industry deployment*	5A. *Early industry consultation*	5B. *Product specification update*
6. *Demonstration version production*	7A. *Industry Consultation*	7B. *Product specification*

[21] Research and Development

update

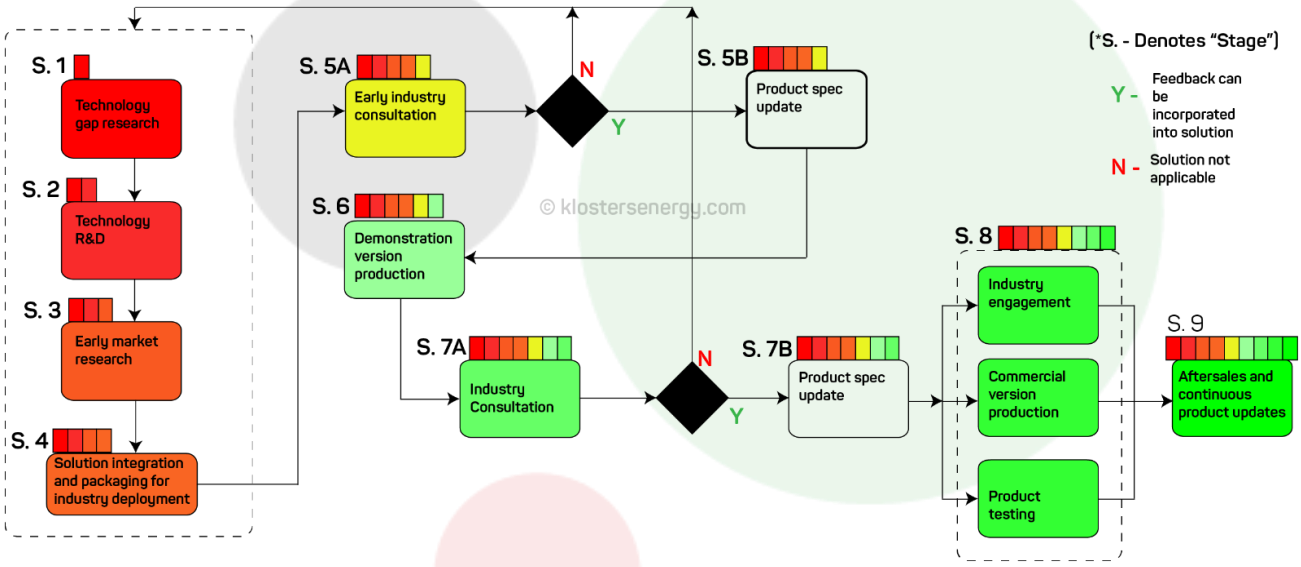
8A. *Industry engagement*

8B. *Commercial version production*

8C. *Product testing*

9. *Aftersales and continuous product updates*

Stages 1-4 are incubation stages, stages 5-7 are intermediate development stages, and stages 8-9 are full scale production and deployment stages.



KadMap® deliverable development process

At various stages of development of a deliverable, key partnerships are instigated for various purposes such as knowledge, consultation, finance, etc. The Liverpool Logistics Offshore and Marine (LOOM) research institute, Liverpool, United Kingdom, our key partner at the stage 2 of R&D, is one of such instances.

From its early beginnings in 2007, KadMap® has evolved into a very potent asset to facilitate and lead the world's fourth industrial revolution – the digital revolution. KadMap® has been through two development phases and is currently on the third.

Phase	Objective	Timeline	Deliverable
1	Develop robust data framework capable of abstracting the assets and operations of EE enterprises	2007-2015	• KadMap® Framework • *Others*
2	Development and packaging of viable digital solutions for EE industry	2014-2018	• KadMap® web interface application (WIA) • *Others*
3	Deployment of solution to EE Industry	2018-2022	• KadMap® OS • KNS • *Others (including KadMap® Apps)*

Phases of KadMap® Development along with objectives, timelines and deliverables

As an engineering company in the energy industry, our journey started with the development of conventional physical services in the form of asset integrity management (AIM) services. With information technology (IT) as one of our major strengths, we also began software designs of novel enterprise AIM systems. Simultaneously, we also began conceptualizing the digital equivalents of these services with application of our engineering knowledge and experience as our targeted users are engineers as well. This prompted the development of a digital framework (which later came to be known as KadMap®) as the backbone necessary to deliver these digital services.

This framework, KadMap®, quickly became the centrepiece of our attention and developments at KES. Our initial services were limited to a section of the lifecycle of EE assets (see illustration below). As we began to see some success in the design of these digital equivalents and the framework development, we realized that the team could replicate such throughout the entire life cycle of an EE asset.

EE Asset Lifecycle

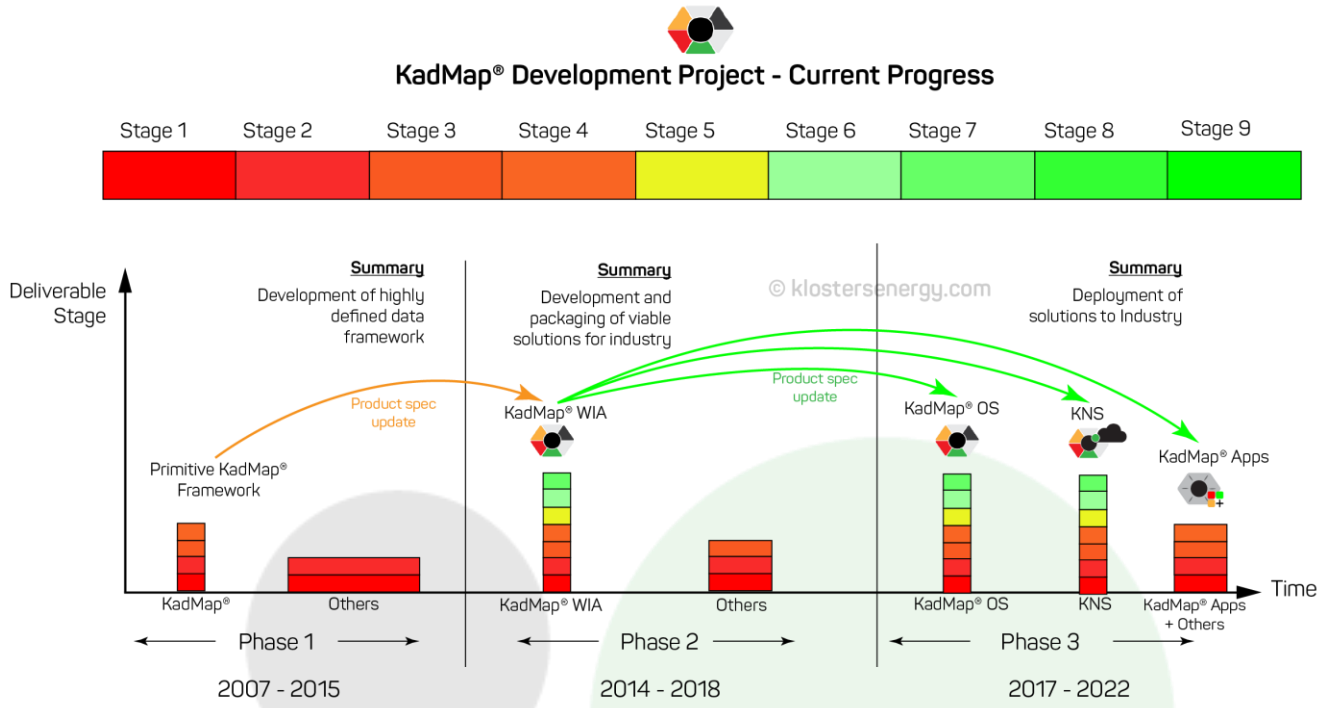
In order to achieve this, we had to increase the complexity and robustness of KadMap®. We also had to device a new strategy of development – the KadMap® development project strategy to maintain sanity and organization even as the complexities and solutions increased.

Sufficient definitions/specifications of the infrastructure, abstraction, data operations and technology marked the beginning of phase 2.

Phase 2 saw us take these definitions/specifications to begin development of KadMap® Web Interface Application (WIA) – to be available/delivered over the www. It also saw the development and deployment of an early version of our first digital service – R-AIM (remote asset integrity monitoring).

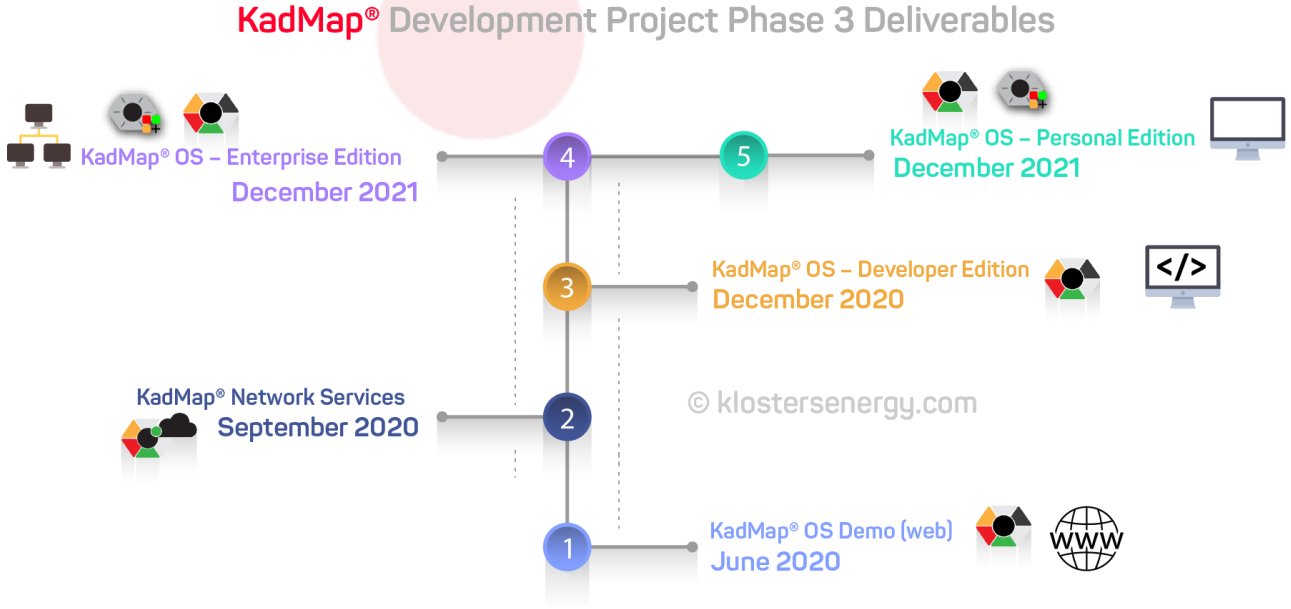
We had positive feedbacks as well as critical comments/recommendations as we went on several industry consultations. The implementations of these recommendations heavily refined KadMap® WIA as it also increased commendations.

The final product specifications update (stage 7A of KadMap® deliverable development process) manifested as evolution of the user interface, critical details of our R-AIM service and eventually the KadMap® WIA architecture. The KadMap® WIA architecture evolved and split to give rise to 3 subsequent deliverables – KadMap® OS, KNS and KadMap® Apps, all inheriting the progress made thus far.



KadMap® Evolution

The evolution of the KadMap® WIA architecture marked the start of phase 3 - the final commercial development and testing of these deliverables as well as industry engagement. Phase 3 is currently underway with key dates as follows:



Key Dates for KadMap® Phase 3 Deliverables

Within phase 3, we are also at the stage of industry engagement (stage 8A) which involves mass industry sensitizations of all product stakeholders in form of targeted media outreach, conferences/exhibitions, road shows, etc. and product launching. As such, we will be hosting and attending a series of industry events which will be announced on our websites (www.klostersenergy.com) and (www.kadmap.com) in the coming months. We do invite you to visit and sign up to our news letters to stay updated on these events and our latest developments.

Afternotes

Klosters Energy Services (KES) is a technology engineering (TechEng) Company - we combine the traditional feel of an engineering company with the futuristic feel of a "Tech" (IT) company.

We provide digital asset solutions with the latest cutting-edge technology with a view to reducing OpEx, increasing asset availability, increasing efficiency, optimizing performance and maintaining a high level of safety for the global energy and engineering industry.

For more information on our solutions, to follow our development, and get updates:

Visit us at www.klostersenergy.com and www.kadmap.com.

Follow us on Twitter : @klostersenergy @kes_kadmap

And on LinkedIn : www.linkedin.com/company/klosters-energy-services-limited

About Industry Papers

KES' "industry papers" is a series of publications focused on propagating awareness and solutions among professionals in the energy and engineering industry. It features captivating illustrations and is written in lecture or first-person explanatory format giving a conversational feeling to our audience.

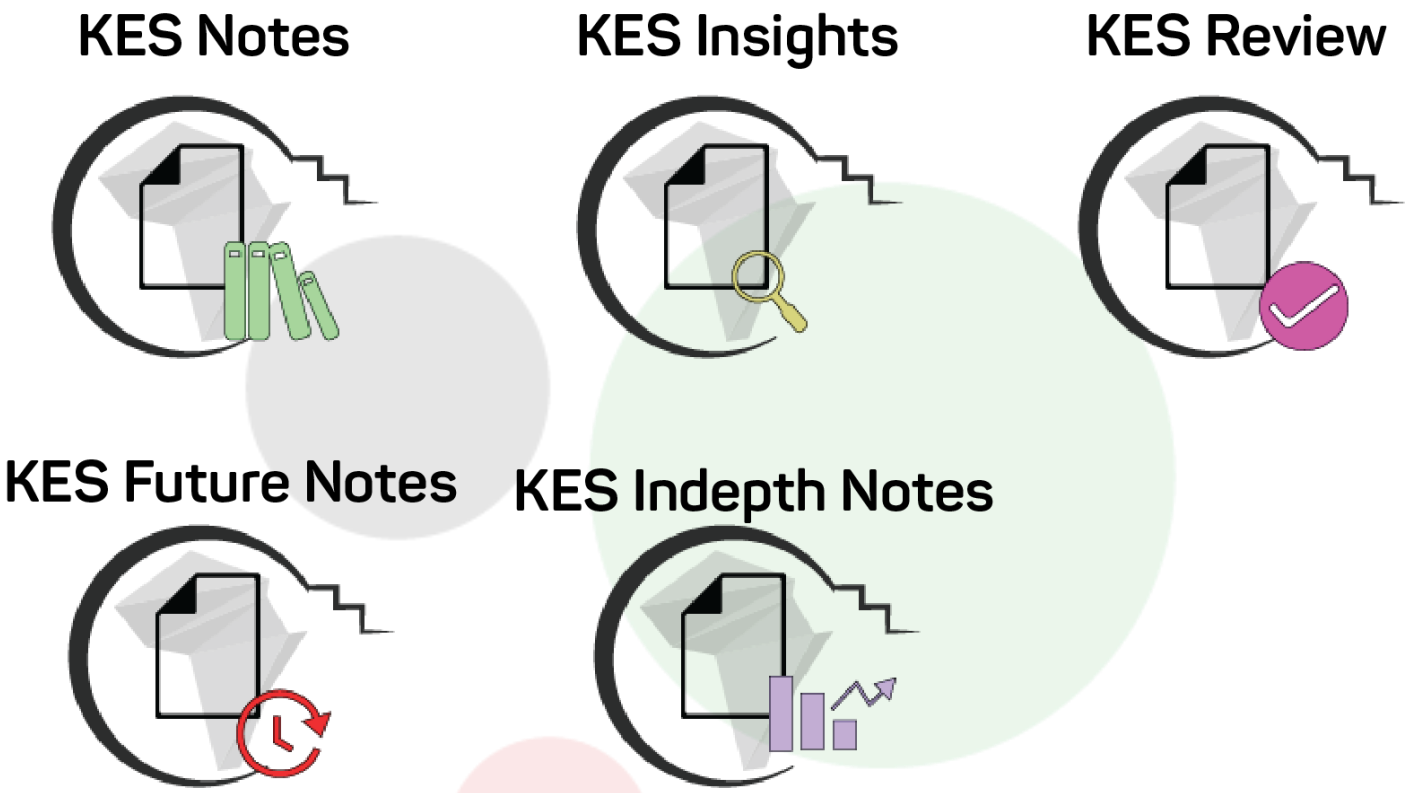
Industry papers uses a unique referencing system and a peer review system populated by our network of academicians and experienced industry professionals. Reviewers of publications can be viewed by the URL provided at the "Reviewers" section of each publication.

About KES Notes

KES' industry papers features various genres distinguished by the focus' depth range and angle on a selected topic. "KES notes" presents a general exposition on a selected topic. Others include:

- KES Insights: It presents KES' perspectives on a given topic of concern

- In-Depth Notes: It presents a more technical exposition on a given topic
- KES Review: It presents our opinions and views on a trending industry topic
- Future Notes: It presents futuristic ideas on certain solutions or scenarios which may not have a complete scientific explanation but will no doubt propel the industry forward



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