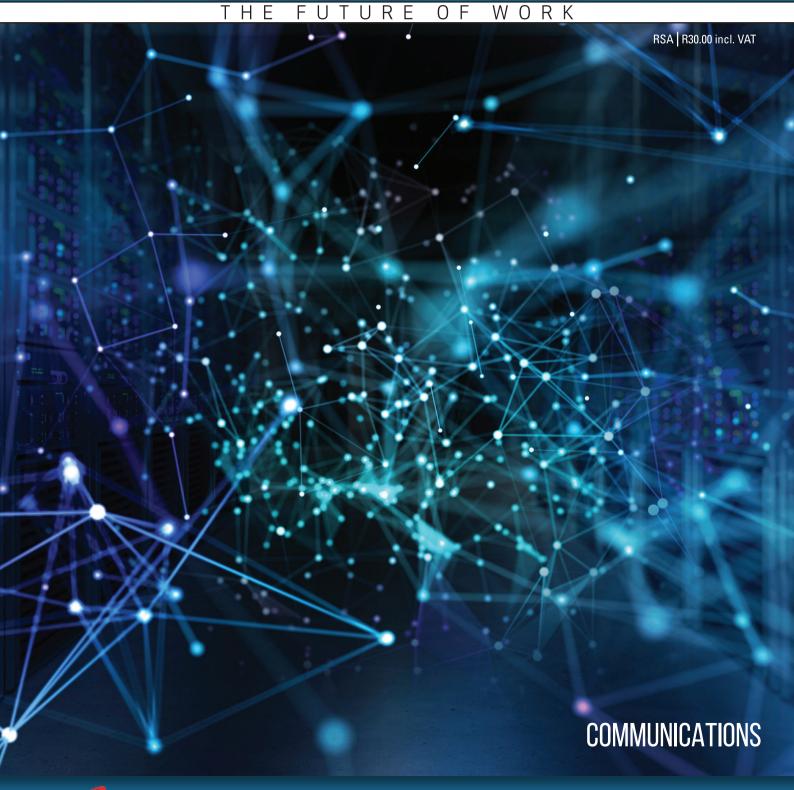# wattnow

THE FUTURE OF WORK

COMMUNICATIONS

WHO WE ARE...

PROF SUNIL MAHARAJ
2021 SAIEE President

PRINCE MOYO
Deputy President

PROF JAN DE KOCK
Senior Vice President

PASCAL MOTSOASELE
Junior Vice President

SY GOURRAH
Immediate Past President

STAN BRIDGENS
Honorary Treasurer

COLLIN MATLALA
Honorary Vice President

CONTENTS

FEATURES

GENERAL

REGULARS

24

36

78

SAIEE   @SAIEE   SAIEE

Dear Valued **watt**now reader

This issue features Communications. For interest, I seek the definition of Communication, which is the act or process of using words, sounds, signs, or behaviours to express or exchange information or to express your ideas, thoughts, feelings, etc., to someone else. Formal: a message that is given to someone: a letter, telephone call, etc.: the ways of sending information to people using technology.

This issue is packed with very informative content. Our first feature article, "Digital, telecommunications, new technologies and 5G", is written by our very own SAIEE President, Prof Sunil Maharaj. Find this on page 24.

Page 30 sports and article on Smart Satellite Services, written by Dr Dawie de Wet from Twoobii.

We also take a look at the future and what it holds for us in communications technology. Find this article on page 54.

Dudley Basson wrote another article on Quantum Communications and shares exciting links and news pieces with us on what is currently happening globally. Find this on page 78.

I am calling on all our SAIEE Female members to please submit a photo and a bio of yourself to be featured in the August issue of **watt**now, where I would like to showcase our ladies. Please email your bio in a word document and your photo as an attachment to minx@saiee.org.za. The deadline is 9 July 2021.

Herewith the July issue; enjoy the read!

Minx

SAIEE Coffee table book

MORE *Sparkling Achievements*

Highlights of Electrical Engineering in South Africa **SAIEE**

Second Edition

Work contacting organisations started in February 2019 and went well until the onset of the Covid 19 pandemic, after which it gradually became challenging to entice companies to participate. Numerous companies had retrenched staff and were in serious financial difficulties. However, we eventually gathered together sufficient material to make the book viable.

One of the most outstanding inputs is from the Square Kilometre Array (SKA) Radio Telescope organisation in the Western Cape. All inputs are exciting, and we feel confident that the book will be an outstanding success.

This softcover book will be available at R350 (incl. VAT) from the Institute and uploaded onto the SAIEE website. The book will be ideal to grace the company entrance foyer and CEO's office and will go to press during April 2021. The cover of the book is shown here.

To order your book, please contact Dudu Madondo either via email: reception@saiee.org.za or contact her on 011 487 3003.

In 2001 the SAIEE published a coffee table book titled "Sparkling Achievements". The book was compiled and edited by Michael Crouch, a Past President of the Institute and published for the SAIEE by Chris van Rensburg (Pty) Ltd.

This first book surveyed Electrical Engineering in South Africa and included material from 43 local organisations. The second edition's objective is to include new companies and their history and achievements during the past two decades from 2001 to 2021.

Dear Valuable SAIEE member,

SAIEE CHARGE REWARD PROGRAMME

Dear SAIEE member,

I hope that you receive this letter in good health and spirits.

The Charge Reward Program is now in full swing since being introduced, with members in good standing eligible to gain points for attending SAIEE events. This process is automatic for you and the appropriate points are allocated post-attendance. Please remember to use the unique hyperlink that was sent to you to check the number of points that you have already accumulated.

A bug was detected in the system in the last few months whereby intended accumulation and redemption points for various activities were incorrectly programmed into the system, allowing members to gain far more points than was intended. This was subsequently corrected, and you can rest assured that the points allocated to you do stand. Redemption opportunities were also revised to align them with the actual cost of the service. Do remember that we are constantly refining the program to ensure that you get the most out of it and your SAIEE membership.

The Program operates on a 5-year cycle starting from 01 December 2019. Members will be able to accumulate points for 5 years, after which the points are reset to 0 and a new 5-year cycle begins. Within the 5-year cycle members can redeem points for listed redemption (discharge) events. The matrix for Charge and Discharge events is shown elsewhere in this publication.

Wishing you all the best in Charging up!

Yours Sincerely,

For more information, on how this programme works, click here.

Yours faithfully,

Leanetse Matutoane
Acting CEO

CHARGE REWARD PROGRAMME

MEMBER LOYALTY

We appreciate
our Member's
support
for 110 years

REWARD

A unique reward
programme
exclusive to
SAIEE Members

FEEDBACK

We received
your feedback
and we listened
to added benefits

EARN POINTS

Earn Charge Rewards
by attending events,
courses or writing
articles

SATISFACTION

We want you,
our Valued Member
to feel satisfied
when working with us

LOYALTY PROGRAM

Redeem your
Charge Points
towards
CPD credits

QUALITY

We guarantee
top quality events,
courses, and
services

SERVICE

We are here
to serve you,
our Valued Member
better

RESPECT

We respect you
and want to see
value for your
hard-earned money

SUPPORT

We are here
to answer any
queries you
might have

For more information:

Visit your Membership Porthole on the SAIEE Website:
www.saiee.org.za

Alternatively, call Connie on 011 487 3003.

CHARGE
rewards programme

INDUSTRY AFFAIRS

SAPVIA welcomes generation threshold increase

The South African Photovoltaic Industry Association (SAPVIA) thoroughly endorses this week's announcement by the President to raise the licensing threshold for embedded generation plants to 100MW.

Welcoming the news, SAPVIA considered this a great day for South Africa. As we work to recover from COVID-19, the Association felt that this increase will be viewed as a watershed moment for industry in South Africa. By developing policy to enable further increases in the uptake of embedded generation, the Solar PV industry will be better able to increase energy accessibility, energy availability and energy security which the economy so desperately needs.

In response to the announcement, Niveshen Govender, (COO of SAPVIA) said, "The signal from government is a strong one: that we must work together to overcome the energy crisis we find ourselves in.

"Being a strong proponent and long-time advocate for this, SAPVIA is delighted that the President has considered, reflected and acted on the advice from various sectors to raise the licensing threshold and has seen fit to do this with appropriate haste during a time of crisis. This move will help us deliver much needed clean electricity, rapidly, to businesses and individuals across the country while creating opportunities for sectors such as agriculture, mining, hospitality and commercial properties to generate their own electricity and relieve the pressure on Eskom.

"SAPVIA continues to support a just energy transition that leverages the abundant natural resources we have here in South Africa, with a specific focus on solar PV due to the prevalence of solar as well as the fact that it represents the least-cost, quickest-to-build, quickest-to-commission option of all the renewable energy technologies.

We must work together to deliver a just energy transition that is fundamental to South Africa's future economic and social development. The solar PV sector, as our Solar PV jobs study demonstrated, carries significant job creation opportunities for South Africans, across its wide value chain, and this increased licensing threshold will unlock more job creation opportunities within the sector.

"This announcement will pave the way to the development of a more robust commercial and industrial market segment, with assumed growth of 500MW per year from private distributed solar PV generation. The potential impact here could be game-changing for the economy with local participation at a global standard, creating jobs and potentially seeing the creation of more, successful, locally-owned SMEs.

"Employing this directive from the President will be seen by the updated ERA Schedule II gazette under the leadership of Minister Mantashe. The processes to implement must be carefully considered from a central energy planning, system operator and management point of view.

Niveshen Govender
COO | SAPVIA

"It will be critical, for the full realisation of the sector's potential, for the DMRE to ensure clarity on the terms of the exemption as these should also include projects that are selling or trading electricity back to the grid, as has been widely called for by industry. For this increase to have the impact we desire of increasing capacity and ameliorating load shedding. We need to work in partnership with the private sector to fully capitalise on the opportunity this threshold increase presents us with. We would urge NERSA, Eskom and municipalities to move with the same haste as the President and Minister Mantashe to ensure that distributed generation supply is implemented smoothly.

SAPVIA will continue to support our members, wider industry and government to ensure that we take the necessary steps and plan effectively to ensure that the country's infrastructure and distribution network can manage this change. Through the Association's structure, programmes and initiatives we will support the industry to deliver a safe, responsible implementation of distributed generation across South Africa." wn

Danfoss showcases its expertise with Eurocool HVAC roadshows

The Danfoss road show in Middelburg, South Africa

Roy Naidoo
Danfoss Climate Solutions Sales Director,
Danfoss South Africa

Danfoss, a market leader in the manufacture of variable speed drives, soft starters, refrigeration components, compressors and switches, recently took part in a number of different road shows around the country, with further events to come.

Danfoss is a supporting partner of Eurocool, a leading wholesaler in the HVAC and refrigeration industry, which is part of the Beijer Ref AB Group.

The Eurocool 'On the Road' 2021 Expo kicked off in April, hosted at the Eurocool Middelburg and Pretoria branches. Follow-up events were then planned for Randburg (Gauteng) and Bloemfontein in June, and Cape Town and Durban in July.

This expo is intended to demonstrate the latest energy-efficient products, outlining and demonstrating the benefits of the product to the HVAC and refrigeration industry, as well as

giving delegates the chance to meet different partners in the industry and interact with them on various technical aspects of the products and solutions.

"The events provide an informal yet strongly interactive platform for the HVAC and Refrigeration industry to engage in discussion about challenges and solutions, and discuss the latest technologies available," explains Roy Naidoo, Danfoss Climate Solutions Sales Director, Danfoss South Africa.

Danfoss has presented a number of different topics at the road shows via streaming videos, including wider information on the increased reliability of AC systems and industrial refrigeration trends, as well as more focused, specific topics such as how an HVAC split mini-system works and how to prevent compressor failure, to name just a few.

"A presence at live events offers

excellent access to a targeted and interested audience, as well as offering the opportunities for networking and staying on top of industry trends and customer pain points.

"The Eurocool road show events are giving us the opportunity to showcase Danfoss' credibility and brand, which is why we strongly support the ongoing and enduring value of live events, wherever possible, as a vital complement to online information in today's digital world," Naidoo concludes. **wn**

ON THE ROAD

2021 Expo

INDUSTRYAFFAIRS

New Safe, Non-Contact Clamp Meter for Voltage Measurements

The Fluke 377 FC and 378 FC True-rms clamp meters use Field-Sense™ technology to make testing faster and safer, all without touching a live conductor for accurate voltage and current measurements.

The new Fluke 377 FC and 378 FC Non-Contact Voltage True-rms AC/DC Clamp Meters can measure voltage and current simultaneously without touching a live wire.

Any time an electrician or technician makes a voltage measurement on a live conductor, there is a risk of electrical shock. COMTEST, Fluke's local channel partner, has their new Fluke 377 FC and 378 FC Non-Contact Voltage True-RMS AC/DC Clamp Meters, that minimise this risk because they are the only clamp meters that make accurate non-contact voltage measurements without test leads.

The Fluke 377 FC and 378 FC True-rms clamp meters use Field-Sense™ technology to make testing faster and safer, all without touching a live conductor. Users get accurate voltage and current measurements through the clamp jaw. Simply clip the black test lead to any electrical ground, put the clamp jaw around the conductor and see reliable, accurate voltage and current values simultaneously on the dual display.

Both clamp meters offer complete 3-phase voltage and current tests in three quick steps. A full set of phase-to-ground and phase-to-phase values are displayed on the meter. These measurements along with phase rotation information are displayed on your smart phone and saved to the cloud via Fluke Connect software, eliminating the need for handwritten notes or complicated math. With Fluke Connect, users can remotely log, trend, and monitor measurements to pinpoint intermittent faults. This data gathered can be used as a basis for designing a preventive maintenance program.

The 378 FC also includes a unique power quality indicator that senses PQ issues — relating to current, voltage, power factor, or any combination of the three — automatically while capturing voltage and current measurements. With this PQ indicator, it is easy to quickly determine if an upstream supply problem exists or if there is a downstream equipment problem.

These clamp meters come with an iFlex flexible current probe that can measure ac current as high as 2500 A — even in tight spaces. Also included are a TPAK magnetic hanging kit with a 23 cm (9 inch) hanging strap that allows the clamp to be hung wherever it is needed, a premium carrying case, TL224 test leads, TP175 Twist Guard Test Probes, and an AC285 black grounding clip.
For more info, email COMTEST. **wn**

New Compact Capacitive Sensor

INSTROTECH, local representative of SELET has a new design for a series of capacitive sensors with more compact dimensions than traditional sensors on the market – 40 mm in total, of which 33 mm is the threaded section for the flush version, and 50 mm in total, for the non-flush version. New constructive technology played a large part in the development of these products. The sensitivity adjustment is not via a trimmer but uses a 'teach-switch' located at the back of the sensor.
For more info, email INSTROTECH. **wn**

TEACH-IN

HIGH SENSITIVITY FOR ALL TYPES OF MATERIALS

360° VISIBLE LED

NICKEL PLATED BRASS BODY, 40 mm LONG

100%

SELET K02 Compact Capacitive Sensor

Global Expansion as interest in Booyco PDS grows

South Africa is a global leader in safety regulations as they relate to proximity detection and collision avoidance.

Anton Lourens, CEO of Booyco Electronics

From its solid foundation as the pioneer of and leader in Proximity Detection System (PDS) in South Africa, Booyco Electronics is making rapid headway in growing its global footprint.

Having recently made export development a strategic imperative, the company is seeing enthusiastic uptake of its home-grown technologies, according to Booyco Electronics CEO Anton Lourens.

"These are exciting times, where we are already doing business in Southern Africa, West Africa, South America and Australia, while seeing considerable interest from countries in Europe and North America," says Lourens.

"Expanding our footprint has been made possible by building strong relationships with experienced channel partners who serve and know these mining regions."

Booyco Electronics' journey into international markets began many years ago through its involvement with the Earth Moving Equipment Safety Round Table (EMESRT), Lourens notes. This global initiative of major mining companies guides best practice in minimising vehicle interactions and collisions.

With South Africa leading the world in regulating this space, Booyco Electronics was, and still is, able to contribute valuable insights to this global forum – based on its market leading PDS technology and experience in the field.

"When we began designing our latest Booyco CXS generation of collision avoidance technology, we developed a solution that would lend itself to application in international markets," he says. "We then identified and engaged reputable partners who understand their customer base and are technically capable of supporting our innovative product line."

The first Booyco PDS system exported from the South African facility was installed in Madagascar about five years ago. This has been followed by further international installations in Ghana, Namibia and Chile.

"With our focus on developing safety equipment that ensures every employee returns home safely every day, we collaborate with responsible, diligent partners who apply their technical resources to realising that vision on individual mine sites," he says.

Key relationships have been established with Australian smart technology company RCT, with Ramjack Technology Solutions and with Insucam. RCT has operations in 70 countries, Ramjack Technology Solutions provides system integration services globally and Insucam has a strong South American footprint.

"While our channel partners support the technology and the end-customer, there is also significant value-add in our collaboration as our partners are already experts in automation, remote control and interfacing," says Lourens. "Their experience in on-mine implementation opens doors to integrating our various technologies to the customers' benefit. We can even incorporate their technologies into our solutions." **wn**

Two Rivers Platinum Mine sees a breakthrough in underground communications

Two Rivers Platinum, a sizeable underground platinum mine located in Steelpoort, Limpopo, has made great strides in setting up a reliable underground Wi-Fi network, providing wireless services to the rock face and full wireless coverage from the face to the tipping area.

This marks the first time in 15 years that the organisation has seen consistent communications from deep within the mine while realising the benefits to be gained via location-based services, such as the remote monitoring of its underground fleet and real-time location data, as well as information on the health status of these vehicles.

OVERCOMING UNIQUE UNDERGROUND CHALLENGES

A fully mechanised underground platinum mining operation that employs over 3,200 employees, Two Rivers is a joint venture between African Rainbow Minerals (ARM) (54 per cent) and Impala Platinum (46 per cent), which is managed by ARM.

According to Two Rivers' Business Leader, JJ Joubert, one of the mine's overriding strategic objectives is to achieve efficient operations, underpinned by technology support. However, due to the complex environment, where challenges include the density of the rock, establishing a stable underground communication network at Two Rivers has been difficult.

"The use of Wi-Fi communications underground is not new in terms of large mining setups, but our mine specifically is comprised of narrow, dense tabular rock. This posed a unique obstacle for Two Rivers since many communications networks, like radio-frequency identification (RFID) technology, require line of sight to be effective. This lack of visibility meant that the Ethernet Line Termination Equipment (eLTE) connectivity was not a viable option either."

From a safety perspective, Two Rivers already had several underground communications measures in place, such as two-way radios and Bluetooth tracking, enabling early communication in the case of an emergency. Still, the previous system's setup was at a fixed point, some distance away from the operating face of the mine.

This meant that to make a simple emergency call, an employee might

have had to walk back quite a distance to reach the comms point to inform mine management of any urgent issues or specific needs.

Furthermore, administration within the mine was historically heavily paper-based, adds Reynard Cronje, IT Coordinator at Two Rivers. "The miner would go underground and complete the requisite paper forms, which were then only returned to the surface at the end of the shift. This meant that the mine could only respond to information after the shift had been completed.

With our equipment upgrades to smart machinery, with the ability to communicate, we needed a network that could facilitate this."

BETTER USE OF DATA, IMPROVED DECISION MAKING

"Data is power," Joubert continues. "And access to data empowers you to make immediate decisions based on real-time information. This has a significant impact on costs for a mining operation and provides endless opportunities for automation with other equipment throughout the business. Live condition monitoring is critical for mining operations. If you can access real-time data on operations, equipment and machinery and respond timeously to this, you can make informed decisions based on the trends uncovered by this data. Therefore, we needed to introduce live condition monitoring and a live information feed from our smart machines and people underground."

A WORLD WI-FI FIRST

"Our Wi-Fi dialogue with Datacentrix, an established preferred IT partner of Two Rivers, started as a casual conversation," Joubert explains. "The Datacentrix team put its head on a block when it came to the proof of concept (PoC) project we rolled out last year. The technology put forward is not typically used within the mining context, making it the first time in the world that underground distributed Wi-Fi has been attempted at this scale."

Says Shawn Marx, Business Unit Manager: Converged Solutions at Datacentrix: "The technology proposed to Two Rivers had to be 'ruggedised' to withstand the harsh mining environment, including blasting taking place underground. It also

needed to be customised to meet the client's specific requirements, so an off-the-shelf type product was out of the question.

"Mines are dynamic environments that are always changing, and the solution needed to be able to adapt as the mine evolves and, as the face moves forward, so does the infrastructure."

After testing several potential scenarios, the most effective solution comprised the use of Wi-Fi. "This particular PoC leverages the cost-effectiveness and ease of integration of Wi-Fi," Marx adds.

The distributed architecture installed at Two Rivers Platinum incorporates a central access point capable of connecting up to 48 easily installable remote antennas. The benefit of this technology is that it uses a single frequency network, so all antennas and endpoints connect on the same channel, therefore reducing interference.

The smart antennas provide Wi-Fi 6, the great enabler for convergence between information technology (IT) and operational technology (OT) networks while enhancing signal strength and coverage area within specific spaces. They are also equipped with Bluetooth 5, used for location-based services.

ENABLING A SIGNIFICANT COMMS ADVANCEMENT

"This proof of concept with Datacentrix was the first time in 10 years in the board and pillar mining industry that we've made a breakthrough with underground communications," states Joubert. "While previously we have not been able to achieve a stable network, we're now seeing very reliable communication coming from underground. It's live, immediate and working – to the extent that we can now even run virtual meetings underground."

One of the significant values realised via the PoC to date is the enablement of location-based services. The project incorporates a service engine that provides location tracking and triangulation, which can distinguish between machine, man, and other assets within the mine. The tracking function can display patterns, such as employee routines for specific days, heat mapping for certain times, and extensive contact tracing functionality for added health and safety benefits.

"Communications are immediate, and technicians are empowered to carry out faster fault finding and closing out.

Equipment, such as our underground mining load haul dump (LHD) loader, boom drill rig and utility vehicles, is also feeding live data, so the status of each machine is available for proactive maintenance purposes, from diesel running low to an engine overheating.

"In addition, emergencies can now be fast-tracked via the Wi-Fi network. Where previously the control room may not have been able to envisage the issue, now both video footage and photos can be communicated, accelerating the proper response.

"We believe that these advantages will completely set Two Rivers Platinum apart going forward, as our improved ability to react to challenges makes fully autonomous mining a possibility, as well as providing us with access to even greater innovation. This technology is set to take mining into the future," says Joubert.

As a Huawei Gold Partner, Datacentrix provides Huawei's portfolio of enterprise wireless solutions. Datacentrix has achieved its IT Certified Service Partner (CSP) 3-Stars certification from the global ICT infrastructure provider, further qualifying the company to solve the challenges of digital transformation through the partnership. wn

SABS

One Young Professional has the opportunity to attend the IEC Young Professionals Workshop to be held in conjunction with the IEC General Meeting: 03 – 07 Oct 2021.

INVITATION

South African young professionals, Engineers, Technologists from the Electrotechnical discipline are invited to partici pate in the 2021 IEC Young Professionals Workshop by writing an essay on the following topic.

TOPIC

What role would Cyber Security play in Standardization to ensure the increasing resiliency of our national Electrical grid, and how would this impact different parts of the economy and society?

GUIDELINES

1.   Essays must be typed using (Arial,11 point) and should consist of +/- 3500 words
         (5 – 6 pages excluding the cover sheet provided).
2.   Essays must be original and unpublished; plagiarised entries will be rejected.
3.   Essays must be written by the entrant; co-authored essays will not be accepted.
4.   Copyright of the essay entered will be assigned to the South African Bureau of Standards.

ENTRY REQUIREMENTS

1.   This competition is only open to South Africans citizens aged between 20 – 35
2.   All essay entries must be submitted to iec@sabs.co.za no later than the 30th July 2021

FOR MORE INFORMATION

Please contact Mr Johnson Marema at: johnson.marema@sabs.co.za

ICT Sector:
Don't rely on the grace time to comply with ICASA's new ownership requirements

Companies in the Information, Communications and Technology (ICT) sector have steep Broad Based Black Economic Empowerment (B-BBEE) requirements and tight deadlines to meet if they want to keep their license to operate from the Independent Communications Authority of South Africa (ICASA).

In March this year, ICASA gazetted new regulations obliging companies requiring a license to have a minimum B-BBEE Contributor Status Level of four and demonstrate 30% B-BBEE ownership.

Though companies have a grace period to achieve a Level 4 B-BBEE rating, Deon Oberholzer, CEO at Gestalt Growth Strategies, says that the new ownership requirement is likely to have caught many licensees off guard, including existing licensees that comply with the 30% Historically Disadvantaged Groups (HGD) ownership requirement.

"Ownership is an aspect of B-BBEE that companies in the ICT sector may have neglected and many have relied on their compliance with the 30% HDG ownership requirement. Now, licensees must have HDG participation at 30% as well as 30% black participation in order to comply with the new regulations and qualify for a license," says Oberholzer.

HDG includes black people as defined in the BEE Act but the definition also includes all women, people with disabilities, and youths who are citizens of South Africa, irrespective of their race or date of citizenship.

However, according to the new regulations around the Limitations of Control and Equity Ownership by HDG and the application of the ICT Sector Code, a licensee must have a minimum of 30% of its ownership equity held by HDGs, and 30% of its equity held by black people, determined using the Flow Through Principle. In a nutshell, the Flow Through Principle means that this 30% ownership must be 100% black and may not have any white or non-qualifying black participation. The new ICASA requirements effectively void the requirements on HDG as it only focus on the Black component of the definition.

"We anticipate that ICASA will stand firm on the ownership requirement, even if it does allow progression of companies from Level 7 to Level 4 by other means. Simply having 30% of ownership held by HDGs is not going to suffice anymore. Licensees are going to have to urgently relook at their

B-BBEE strategies and start taking steps in the right direction to comply if they want to retain their licenses," Oberholzer reiterates.

Exempted micro enterprise (EME), being companies with an annual total revenue of R10-million or less, and qualifying small enterprises (QSE), being those with an annual total revenue of between R10-million and R50-million, also need to comply with the 30% BEE ownership and have 48 months to comply. Generic licensees have only 36 months to show compliance.

Licensees have to submit the necessary documents confirming their B-BBEE Contributor Status Level on an annual basis during the transitional periods. This annual reporting requirement confirms that they will have to ensure the retention of their ownership and BEE levels during a licence period.

Oberholzer warns that relying on the grace period is short-sighted and could turn out to be very risky.

"Companies that don't currently comply will be under pressure when it comes time to submit their annual reports to ICASA, which may frustrate or delay the process if licensees are not compliant from the onset.

"We recommend that current and prospective licensees start looking at their B-BBEE compliance now. By meeting the 30% black ownership and Level 4 requirements in their current financial year, they can protect their companies from this."

Oberholzer concludes saying that an essential first step is to have a strategy. "Don't panic. With a properly structured 30% black equity ownership plan, achieving Level 4 is possible, even for small businesses. Focus on setting your strategy. Following that, you can start implementing and preparing for verification before the grace period ends."

Established in 1998, Gestalt uses original and proven business transformation models to help companies unlock business growth and shareholder value through B-BBEE. wn

Smart Satellite Connectivity Service Offers Solutions to Latency Issue

Satellite internet connectivity has been available for some years across much of Africa and has become established as a good option for remote business locations (such as mines, lodges and farms) looking for reliable connectivity in areas not typically serviced by fibre or LTE.

The launch of new satellite networks has brought this technology back into focus but, has also reignited the debate around latency – an issue which many customers still seem to associate with satellite internet services.

"We welcome the buzz surrounding new international entrants into the market, and we are confident it will translate into an increased desire among businesses to look closer to home for fast, reliable satellite broadband – especially now that we have addressed legacy latency issues," commented Dawie de Wet, CEO of Q-KON, the satellite engineering enterprise behind satellite internet service Twoobii.

Latency refers to any delay in information transmission times for data – in this case, from the source to the destination via an orbiting satellite. With these timeframes being measured in milliseconds – that is, thousandths of a second – 'delay' is too big a term for what are exceptionally short periods of time. Despite this, latency has traditionally been used by proponents of other connectivity technologies as a stick with which to beat satellite internet services.

Latency is a feature of all broadband networks, including 5G and fibre. However, satellite internet involves transmitting and receiving signals over much longer distances. These can be

from 500km to 1500km, in the case of Low-Earth Orbit satellite constellations (or 1 000 to 3 000km for the 'round trip', which is the measurement used for latency calculations) – these are the satellites used by some high-profile international satellite internet service providers.

Twoobii's service uses Geostationary Earth Orbit (GEO) satellites. These are positioned further from the Earth, and orbit at a distance of 35 786km. This difference in height above the Earth's surface is reflected in the latency figures achieved by LEO satellites (8 – 25msec) and GEO satellites (550msec, or just over half a second). To put this in perspective, that's approximately

the time it takes a person to say 'hello'.

De Wet explained that outdated perceptions of latency have much more to do with people's experiences of using less advanced computer applications which were not fully compatible with satellite communication links.

Computer technology has of course moved on, and today's PCs and laptop applications have no issues in receiving and transmitting voice, video and other data signals.

Today's Smart Satellite networks, such as the Twoobii-on-Flex service operated by Q-KON on the Intelsat Flex networks, incorporate advanced data communication features which seamlessly integrate user applications such as voice and video calls, effectively making latency no more a factor with satellite links than it is with any other type of data network.

De Wet further explained that Twoobii is not positioning itself as a competitor technology to 5G and fibre, but rather as an alternative connectivity solution for situations where its unique advantages are applicable to the challenging situations often found in Africa.

Twoobii is effectively busting the 3 major myths of satellite services, namely - it's expensive, it's slow and applications don't work due to latency.

Twoobii is able to offer services over huge areas, and as it is not affected by outages such as loadshedding, it offers unmatched availability. This in turn makes it particularly suited to critical service applications such as ATMs and retail POS.

The service is also exceptionally cost-effective thanks to its on-demand billing. Combined with Smart Satellite Technology, this means that Twoobii will prove to be the ideal internet connectivity solution for African enterprise users in off-grid areas.

To discover Twoobii's satellite business broadband offering, click here. **wn**

Renewables offer energy-security

In a bold move last year, the South African government launched an emergency energy procurement plan with a view to relieve the current energy crisis and limit load-shedding. The shortfalls are currently partially alleviated, however at great expense, as there is extensive use of diesel-based open cycle gas turbines.

Such fossil-fuel based contingencies undermine our ability to reduce carbon emissions, curb global warming, and achieve sustainable development.

Dubbed the Risk Mitigation Independent Power Producer Procurement Program (RMIPPPP), the new plan is unlike any of the Department of Mineral Resources and Energy's previous interventions.

Whereas RMIPPPP's predecessors prescribed specific technologies, here any technology type (or combination thereof) in any location is considered if the proposed plans meet the department's stringent criteria around cost-efficiency and dispatchability (the ability to dispatch the right amount of power at the right time according to the needs of power-grid operators).

The RMIPPPP plan, which envisions a total of 2000 megawatts in emergency capacity to be generated by independent producers, is aligned with progressive energy goals outlined in the Integrated Resource Plan (IRP).

The ambitious RMIPPP Program follows the trajectory set by the REIPPP (The Renewable Energy Independent Power Producer Procurement Program), a competitive tender process for grid-connected renewable power which has attracted over R200 billion in private sector investment over the last 8 years.

Since 2013, Independent Power Producers (IPPs) have proven resilient and reliable, and we've seen the plethora of benefits that private power producers bring to the economy: they attract investment, stimulate the market, and reduce the pressure on the nation's fiscus. They bring skills and jobs. IPPs also enhance energy security and help diversify the energy mix.

"The RMIPPPP is a progressive step in South Africa's energy history, and, if successful could revolutionize the way power is generated and procured in the country", suggests Jan Fourie, General Manager in Sub-Saharan Africa of Norwegian renewables giant, Scatec.

Scatec's bid-winning proposals are remarkable in that they are the only successful bids to focus solely on renewable energy.

"Purely renewables-based projects like Scatec's offer economic benefits in that all their costs are embedded in the initial capital expenditure. No fuel is needed to run the project, therefore there is no commodity risk and currency risk to government and no carbon tax", Fourie explains.

"This is exciting for Scatec as we now have the opportunity to demonstrate the viability of renewable energy production and quell any doubts around its cost-competitiveness.

Scatec is also honored to be able to contribute to job creation in South Africa by creating several thousand construction jobs with this project, as well as many permanent positions in operations and maintenance", says Fourie.

During 2020 amidst the COVID-19 pandemic, renewables were the only source of energy to report a growth in global demand. The upswing in renewables' popularity has been driven by widespread government policy support, dedicated procurement programs and continuous innovations, bringing both technology costs and operating costs down.

"The trend is also being shaped by watershed policy shifts around the world. For example, Norway aims to end the sale of fossil fuel-powered cars by as soon as 2025, with many other nations like India, Canada, UK and the EU likely to do the same in the coming decades", says Fourie.

Globally, institutional funds are being pulled out of fossil-fuels, and the coal-based power industry no longer enjoys popular backing. Much public and corporate support has gravitated towards renewables in recent years. Even leading companies in the coal and oil industries are now shifting their focus and investing significantly in renewables.

Fourie commends the South African government for its progressive vision, and admirable commitment to its targets.

He notes that the country's world-class infrastructure that facilitates large-scale generation and distribution, along with treasury's full support for the new power purchase agreements, have resulted in an attractive investment landscape.

Fourie adds that as Scatec expands its foothold in Sub-Saharan Africa, they will be up-skilling to further develop institutional scope and expertise. He says Scatec is currently looking at further forays into wind-based power, as well as other Power-to-X initiatives like green hydrogen and others.

"We are becoming more agile in that we are tech-agnostic and can shape our power solutions to particular situations in specific areas and adapt our strategies accordingly, in order to maximize efficiency", concludes Fourie. **wn**

Why is short term insurance important?

Navigating through tough economic times and cutting back on non-essential costs is always a challenging task at hand. When it comes to short term insurance, this could be very difficult as you might expose yourself if you are not adequately covered.

According to the latest statistics from the South African Insurance Association, about 65% of drivers on South African roads are not covered by insurance, leaving you wide open to quite a few costs in the event of an accident, and you are not adequately insured. You might very well find yourself in the position that you would need to pay for costly repairs, towing and storage, and legal fee's even if the accident was not your fault.

We at SAIEESURE have partnered with market leaders in the industry to ensure we minimise your risk at the best possible rates - exclusive to SAIEE members. Therefore, reducing your risk in an accident or loss event also help keep your costs down to a minimum. We have chosen our partners in the personal and retail space according to their market presence and share and value for money benefits, member benefits, and client-focused approaches.

During our pilot phase, we have contacted and quoted over 40 SAIEE members. We managed to save members money on their monthly premiums, in some cases up to 45%. We also managed to enhance their policies significantly and reduce their exposure for loss.

Another significant benefit that members would qualify for is the rewards program. In this instance, members could save a substantial amount of monthly costs by receiving up to 50% of their fuel purchases back at any BP or Shell service station, depending on their driving behaviour and engagement in the rewards program.

Additional refunds and discounts are available through 3rd party partnerships with retailers like Tiger Wheel & Tyre on purchases of tyres, shocks, batteries, and vehicle services and preventative maintenance through the Bosch Car Service Centre networks, ensuring your vehicle is always safe and reliable at a reduced cost.

We believe we can reduce insurance costs for all SAIEE members through the discounts on the already highly competitive rates combined with the refunds and discounts through partner spend.

We are not solely savings driven. We offer additional benefits that further enhance our offering by keeping you safer. Our world-leading impact alert system alerts the necessary emergency personnel in the event of an impact alert on our telematics device that monitors your driving style and builds a personal driving profile. This device is installed in your vehicle by conveniently booking a pre-inspection at a Tiger Wheel and Tyre close to you. After the impact alert is installed, you have also earned your first driving rewards points, starting the savings process.

Another benefit of the telematics device is that you start building up a driving behaviour profile. Thereby, if you should get hi-jacked or your car stolen, the unit sends an alert to the relevant authorities and gets the help you need when you need it.

Despite all the fantastic benefits that are included in the plan, standards like

car-hire and a flat excess structure, we can customise or tailor-make your policy should you require something a little more specialised some of these benefits include :

WRITE OFF ACCELERATOR: This benefit reduces the amount of damage your vehicle needs to sustain to be rendered unrepairable.

SHORTFALL COVER: This is a prevalent option. This benefit will cover the difference between the outstanding finance amount at any of the registered lending institutions and the current market value of your vehicle as most financed vehicles have a substantial difference between these two values, and this might leave you out of pocket. No Average: Any specified item would be paid out according to the specified amount if proof had been submitted at the underwriting stage.

EXPRESS CLAIMS: Any mobile or computing device would be replaced within 48 hours after receiving the claim documentation.

NO EXCESS ON ACTS OF GOD: On specific plans, there would be no excesses payable on acts of God such as wind, hail, lightning and flood damage.

FLAT EXCESS STRUCTURE: We offer a flat excess structure to eliminate any surprises at the claim stage.

24H LEGAL ASSISTANCE: Members qualify for a 24-hour telephonic legal assistance service.

EMERGENCY ASSISTANCE: Members have access to emergency services in damages to plumbing, electricians or security.

These are some of the benefits our members can look forward to.

If you are interested in getting a no-obligation free quote, please get in touch with us by any of the following methods:

- Send your current insurance schedule as well as a list of any claims in the last three years
- Please specify what you need to be covered and mail it to us at the address below
- Please send your contact details with a quote me in the mail subject
- Send a please "SaieeSure contact me" with your name to 0825535039 **wn**

For more information, contact:
Hano Muller
T: 082 553 5039
Email: insure@saiee.org.za

AN INSURANCE BENEFIT FOR SAIEE MEMBERS

Digital, telecommunications, new technologies and 5G

The digital revolution has affected and continues to affect humanity in many ways, both positively and negatively. This negativity has been exacerbated through the Covid-19 pandemic. The significant effect of the digital revolution is that it has contributed significantly to making the world a global village and manifested the sad reality of the digital divide, which could be correlated with the social divide.

BY | PROFESSOR SUNIL MAHARAJ
SAIEE PRESIDENT

However, through the digital transformation, it is possible to reach, interact, carry out business transactions, etc., across the world in real-time, across different time zones, relative ease, and at an acceptable level of reliability. Currently, digital social media are now more popular and widely used than traditional media outlets for disseminating information. Similarly, entertainment has gone more digital than physical, with billions of users and subscribers using digital platforms like YouTube, Netflix etc.,

in streaming movies and songs, sometimes achieving millions of views in a matter of minutes or hours. The list of areas and aspects of our lives being disrupted or influenced by the digital revolution goes on and on and left to one's imagination.

As the digital revolution continues to influence our lives, it offers many prospects and opportunities, especially in Africa. These opportunities must be well understood to be fully harnessed. The aftermath is that the continent

levels up, especially in technology, with other advanced parts of the world. The SAIEE, through its recently successful 5G series of webinars, engaged its members with many experts presenting on various topics and aspects related to 5G and beyond.

DRIVING TECHNOLOGIES
Several technologies are helping to drive the digital revolution. In the telecommunications space, the new or emerging technologies are referred to as next-generation (xG)

communication networks. The xG technologies are essential drivers or enablers of the digital revolution. Some of the vital xG technologies are a fifth-generation (5G), internet-of-things (IoT), cognitive radio networks (CRN), and next-generation wireless sensor networks (xWSN). The 5G is considered one of the most potent xG wireless communication technologies helping to drive the digital revolution.

5G is the new standard of communication for emerging xG wireless communication networks. Despite the myths, debates, and seaming unease around 5G - most unfounded and outright unscientific - it remains the big deal in telecommunications. The promises and expectations of the 5G network are pretty impressive. The 5G network is expected to achieve communication speeds of about 1 gigabyte per second and latency of less than one millisecond. Furthermore, 5G networks are expected to provide communication to cover almost all parts of the world, and they have incredibly high reliability. These promises and expectations are worthy of making 5G considered and described as a generational shift in wireless communication.

Because of these massive promises of 5G, once it is fully operational, many 5G-based applications will emerge that is expected to have very high social and economic value and far-reaching impact on all aspects of our lives. More so, the 5G network will be one of the essential tools to help drive

the realisation of the much-talked-about and highly anticipated hyper-connected world.

To help fulfil and realise its promises and expectations, without doubt, 5G networks will most likely require large bandwidths and, by inference, huge spectrum frequency bands for their operations. Unfortunately, the spectrum is a limited, non-ubiquitous and highly- competitive communication resource.

The scarcity in spectrum availability to operators is one of the potential limitations to the rollout of 5G networks, constraining South Africa development. By employing CRN in 5G, the limitations in spectrum availability for 5G applications can be significantly overcome, however, based on the business case. The CRN can assist in providing cognitive capabilities for the 5G networks, which can contribute to achieving 5G goals, especially in the areas of latency, speed and network reliability.

CHALLENGES
The digital divide is a term used to describe the gap between demographics with access to modern information and communications technology and those that either does not have any or have only limited access. In other words, the digital divide explains the difference between those who can benefit from the digital revolution and those who cannot.

Many of the countries in Africa are adversely affected by this digital gap. The reasons for the wide digital gap in Africa are numerous - some of which are the low level of technology that is currently operational, poor infrastructural base to support new technologies, reliable energy,

economic challenges, political instability, extreme poverty, mass illiteracy, etc. In most countries in Africa, primary access to the internet is still a severe challenge. Connectivity is low and poor, and most times, the focus is only on the big urban cities while the rural areas are ignored or poorly serviced. Even in parts where connectivity is available, there is a high cost, and as such, affordability becomes a challenge.

The low broadband internet penetration in Africa means that most African countries are not adequately interconnected and, the entire continent is poorly connected to other parts of the world. The implication of this is that the opportunities and privileges that the digital revolution provide cannot be fully harnessed by individual citizens, businesses, governments, countries of Africa and the entire continent to overcome unemployment, poverty and inequality.

OPPORTUNITIES AND PROSPECTS
One of the prospects and promises of the digital revolution is to help bridge the digital divide.

This is especially promising for Africa, where the enormous digital gap provides the best opportunities for innovation to speed up growth and reach. The potentials for xG wireless communication technologies are more readily realisable in Africa. What is required is the proper focus, willpower, leadership, collaboration and support. African countries will have to work together to address common problems and address them locally. Still, international support and collaboration will be needed in helping African countries come to speed with other advanced countries in terms of technology and innovation.

In bridging the digital divide, xG communication networks have a significant role to play. Technologies such as 5G, CRN, IoT and xWSN are essential in that they are active drivers of digital realities and possibilities. The problem of local penetration and broadband access can be addressed with 5G.

In contrast, spectrum availability and optimisation can be mitigated by having a competent and innovative regulator. Already, models incorporating and apply, e.g. cognitive radio capabilities in 5G, are being developed. Therefore, Africa must tap into the wealth of opportunities that these xG technologies provide.

CONCLUSION
The digital revolution has been instrumental in shaping the modern technology-based, globally-interconnected world. Emerging telecommunication technologies such as 5G, CRN and IoT are helping to drive the digital revolution.

The benefits of the digital revolution continue to be seen in health, agriculture, food security, education, the manufacturing industry, and much more. The revolution that transcends the digital revolution brings together the physical, cyber-physical and biological worlds and will change and shape our industries, work, and lifestyle beyond what the digital revolution currently achieves post-Covid-19.

With its more than 1.2 billion population and a high percentage of youth, Africa is in the best position to gear up and leapfrog to benefit from the benefits of the digital revolution and position itself as a global economic powerhouse. I call upon my fellow SAIEE members to take up this challenge! **wn**

DEHN
PROTECTS

Superior Surge and Lightning Protection.

DEHN is your competent partner when it comes to lightning and surge protection for your assets and systems. Our proactive approach helps to prevent damages for companies across a variety of industries.

www.dehn-africa.com

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Lightning Protection Solution for Telecoms

In this digital age, telecommunication lines are vital to ensure that we get information across and stay connected to others. Companies in the telecommunications sector make communication possible worldwide, whether through the phone or the Internet, over airwaves or cables.

The highly sophisticated processes in today's industrial facilities and offices require continuously operating interfaces to the "outside world." Telecommunication line networks often cover several kilometres. As a result, surges are pretty likely to be injected into such large networks.

Installing a complete lightning protection system, which includes an external and internal lightning protection system, is the safest way to safeguard a structure from the destructive impacts of lightning.

RISK ASSOCIATED WITH SURGES

Copper cables with a low shielding effect are utilised in a company's internal cabling system and connect wires to the local exchange. Because the incoming lines stretch beyond numerous buildings, there can be significant potential variations between the building installation and the incoming lines. Switching overvoltages in the power system can produce failure that interferes with the low-power lines if high-power and low-power lines are routed in parallel.

CHOOSING THE RIGHT PROTECTION

All incoming lines exposed to direct lightning must be protected by a lightning arrester, commonly known as type 1 or class 1, employing the Faraday cage concept. This will reduce the current and energy associated with lightning reaching equipment. A switching surge's properties and wave shape are different and lower energy.

Type 2 and class 2 arresters are other names for surge arresters. Combined surge arresters include both type 1 and type 2 arresters in one device. The lightning and surge wave shapes can be handled exceptionally effectively by combination arresters. Mainly when space is restricted, a combination arrester should be considered. Always double-check that the lightning, surge, or combination arresters meet the equipment's specific voltage and communication protocol requirements.

LIGHTNING PROTECTION FOR CELL SITES

The use of mobile networks is expanding, as is the global need for bandwidth, thanks to the phenomenal rise of mobile terminal devices.

High availability and reliability of equipment and system technologies are critical in mobile communications, not only in the private but also in the public sector, such as in security authorities' digital radio systems. As a result, cell-site lightning protection measures are required. Planners, installers, and operators must consider lightning and surge protection while establishing network equipment and designing new sites.

Lightning and surge protection solutions are chosen and placed following the IEC 62305 lightning protection zone concept. This standard defines protection zones.
Different coordinated protection elements are utilised at the margins of such zones.

NEW DEHNVAP FOR CELL SITES

Operators, equipment suppliers, and end consumers are becoming increasingly interested in ultra-reliability. DEHN delivers reliable

solutions in line with and exceeding industry standards.

Additional mobile network technology (particularly 5G) necessitates a higher density of sites. However, there is a finite amount of area accessible for new sites. The new DEHNvap family of products consists of modular, compact combined arresters for protecting the 230/400 V power supply of cell sites. The new DEHNvap is compact while still delivering the same protection standard and embracing 5G ready technology.

The new DEHNvap is compact (at half the size of the previous model) and consists of prewired, spark-gap-based type 1 + type 2 combined lightning current and surge arresters. Armed with maximum system availability, the benefits of following current limiting with the new Rapid Arc Control spark gap technology are endless. The residual energy reaching equipment is the lowest ever. The DEHNvap family of devices offers various solutions to meet the needs of the mobile network industry.

DEHNSECURE FOR DC APPLICATIONS

Both operators and power supply manufacturers trust DEHNsecure lightning current arresters for DC applications. The DEHNsecure arresters combine excellent performance and ease of use. Their electrical specifications and low voltage level are designed to meet the most demanding lightning and surge protection standards.

Our decades of experience in lightning protection and our extensive research efforts have helped us build lightning protection systems for cell sites. The primary goal is to protect antennas, remote radio heads, base stations, and power supply systems against lightning damage.

At DEHN, we have been effectively designing protective solutions for cell sites for over 25 years. We are a leading provider of earthing and equipotential bonding and lightning and surge protection equipment for the mobile communication sector, thanks to our extensive experience.

We assist network operators, power supply manufacturers, system technology providers, and their general contractors and service partners as an all-in-one surge and lightning protection provider. wn

Smart Satellite Services

- THE FUTURE IS HERE

Communications satellites provide two-way voice and data communication between a user terminal and the Internet or enterprise network core. The first communications satellite was the Bell Telstar 1, launched in 1962 to transmit television and voice signals from the USA to Europe.

BY I DR DAWIE DE WET I PR. ENG. M.SC. ENG. GROUP CEO, Q-KON & CHIEF ENGINEER, TWOOBII

OneWeb's fifth launch on March 25, 2021, from Vostochny Cosmodrome saw 36 more satellites added to their constellation.

The satellite industry has grown rapidly since then; around 2018, there was a sudden burst of new constellation and technology developments.

While the basic elements of a satellite communication link remain unchanged, the characteristics and performance have progressed so far that a whole new sector has emerged: Smart Satellite Services

This refers to end-to-end satellite services that incorporate recent developments to deliver enhanced end-user experiences. Here, we'll focus on the architecture, technology and concepts rather than individual specifications.

A CONCEPT WHOSE TIME HAS COME

Smart Satellite Services refers to an industry rather than a specific product, brand or operator. Smart Satellite Services seamlessly integrate the different LEO, MEO and GEO satellite constellations with ground stations and network management tools.

The improved performance in data rates, the reduced latency characteristics and the seamless integration with SD-WAN architectures offered by current and emerging smart satellite services are the perfect answer to outmoded customer attitudes about the speed, cost and latency issues of satellite services.
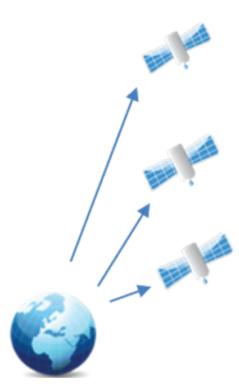
THESE SATELLITES ARE NEW

While the idea of a satellite is not new, it's important to understand that modern versions have evolved in all aspects, including orbital position, control, performance and functionality. The satellites that deliver Smart Satellite Services are indeed new.

Fundamental to the recent developments in the satellite industry are the large-scale use of different orbital planes for communication networks.

Different satellite constellations are located at various heights above the Earth – either Low-Earth Orbit (LEO), Medium-Earth Orbit (MEO) or Geostationary Earth Orbit (GEO).

Traditionally, only GEO constellations were used for communications, and this has shaped the user experience in terms of available satellite terminal equipment, cost of services (a function of the overall satellite launch and operational costs) and network performance, which is determined by the total data bandwidth per satellite as well as by the orbital location of the satellite.

Introducing LEO and MEO services has reduced data latency – a significant step forward in positioning satellite

Geostationary
35,786km

Medium-Earth Orbit
8000 – 18,000km

Low-earth Orbit
500 – 1500km

	LEO	MEO	GEO
Distance from Earth, km	500 –1500	8000 – 18 800	35 786
Typical Latency, msec	8 –25	123 –250	550

services as a more competitive alternative to fibre back-up services or fibre restoration services.

While much of the media focus has been on the introduction of these new LEO and MEO constellations, the introduction of fully digitised payloads, high-power transmitters and software defined architectures has seen GEO constellations also take major steps forward.

All these developments have just one goal in common: to meet the increasing demand for anywhere, always on connectivity.

This is behind the demand for Smart Satellite Services which will drive maritime, mobile and fixed connectivity markets as they become a key element in the communications matrix.

LARGE-SCALE INVESTMENT

The satellite industry is home to some of the most ambitious infrastructure projects in the world including Amazon's Project Kuiper with some 3 236 satellites.

These mega-investments are accelerating a total evolution of the industry that will impact on how satellite services are sold, provided and used. This is a new and dynamic business landscape that offers advantages for end-users globally.

To provide perspective on the underlining growth in the satellite industry and to appreciate the scale of current and planned developments, let's briefly consider the leading active constellation programs currently being built or planned.

332% INCREASE

According to the Euroconsult 2019 report, the past decade has seen a total of 2 298 satellites launched; between 2019 and 2028, a total of 9 935 satellite launches are expected. That represents an average launch rate of 990 per annum or almost three satellites every single day.

Starlink, a constellation built and launched by SpaceX, currently has 1 300 LEO satellites in orbit – but has regulatory approval to launch up to 42 000. This consumer-focused service is projected to be available in South Africa by 2022/2023.

In July 2020, Amazon announced that it had received authorization from the FCC for a constellation of 3 236 satellites and would consequently be investing more than US$10 billion in Project Kuiper. Seen as a direct

competitor to Starlink, Project Kuiper has been largely kept under wraps to date.
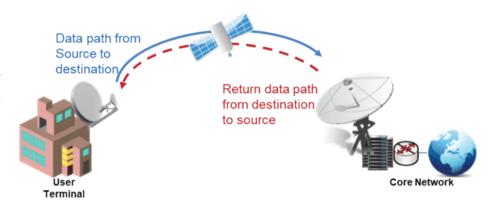
OneWeb is making progress with a LEO constellation of 648 satellites and is already providing services in some jurisdictions. The planned launch date for South Africa is also 2022/2023. Another entrant into this field is the O3b mPower network being built by SES as a follow-up to their successful o3B MEO services.

The Chinese government also has a company dedicated to creating and operating a 13 000-satellite broadband constellation. The State-Owned Assets Supervision and Administration Commission (SASAC) issued a press release in April 2021 announcing the creation of the China Satellite Network Group Co. Ltd.

Spectrum allocation filings submitted to the International Telecommunication Union (ITU) by China in September 2020 revealed plans to construct two similarly named "GW" LEO constellations totalling some 12 992 satellites.

LATENCY IN SMART SATELLITE NETWORKS

Latency is any delay in the time it takes to transmit information from one point to another. In the case of satellite signals, these very short intervals are usually measured in milliseconds (msec). For practical reasons, latency is measured for the round trip of known distances, i.e. the time the data takes to travel from source to destination and back again.

Data path from Source to destination · Return data path from destination to source · User Terminal · Core Network

For satellite networks, latency is determined by the distance between the satellite and Earth and the speed of the signal. For LEO satellites – those closest to the Earth's surface - the latency will be 8 – 25msec. For GEO satellites – those furthest away - latency rises to 550msec.

To put this into perspective, 550msec is roughly the time it takes to say 'hello'. In the past, satellites were criticized over their inherent latency. Historically, it was true that latency complicated real-time applications such as voice and two-way video.

The development of Smart Satellite Services has resolved the issue of latency to the point that they can effectively support voice, video and corporate data applications.

New and emerging LEO and MEO satellites offer a latency of just 30msec, which is comparable to terrestrial networks.

GEO Smart Satellite networks, such as the Twoobii-on-Flex service operated by Q-KON on the Intelsat Flex network, incorporate advanced data communication features to seamlessly integrate voice and video calls within the satellite communication path, thereby addressing any potential latency issues.

SMART DATA NETWORK SATELLITES

Smart Satellite Services offer both Layer-3 and Layer-2 connectivity options for easier integration with existing LTE and fibre networks.

Layer-2 (the Data Link Layer) is used to transfer data between adjacent network nodes in a wide area network or between nodes on the same local area network. Layer-3, in contrast, is a segmented routing over internet protocol (IP) network.

Layer-2-over-satellite (L2oS) permits the implementation of a Layer-2 network with network routing performed by end-user network end points. This greatly simplifies the satellite network architecture and enables seamless integration with core MPLS networks, thereby unlocking performance and operational advantages:

IMPROVED EFFICIENCY

Layer-2 enables MPLS to be used across the satellite link, eliminating the need for tunnelling to extend the customer MPLS. By removing all routing from the satellite network segment, and implementing this in the end-user end point equipment, the need for encryption over the satellite links is eliminated and end-to-end efficiencies are improved.

IMPROVED SD-WAN PERFORMANCE

Layer-2 offers a >30% increase in throughput performance and user experience when compared to a Layer-3 connection.

END-USER ROUTING ARCHITECTURE

With no routing functionality in the satellite communication links, core network architects can implement end-to-end routing topology to comply with application requirements. From a remote satellite terminal perspective, the fact that there is only one 'hop' between the CPE and the core router simplifies new site configuration and deployment.

DECENTRALIZATION

Smart Satellite Services also incorporate advanced VLAN functionality which enables different network end points for different customers, who can be geographically remote from each other.

MORE SMART NETWORK FEATURES

Smart Satellite Services can also offer features such as data VLANs, Advanced Quality-of-Service and seamless integration with SD-WAN networks, all of which support end-to-end integration.

Traditional VSAT networks were only able to provide standard routed Layer-3 services, with VSAT modems performing basic routing functions. However, changes in the complexity of remote sites required protocols like VLANs to logically separate groups of users and applications. VLANs simplify the integration of different users and applications into a core network, so satellite modems are required to support them.

Smart Satellite services such as Twoobii support multiple VLANs and enable them to separate business traffic, broadband traffic and real-time traffic. Specific routes are then applied to each VLAN, allowing business traffic to go directly into the customer core network and broadband traffic to flow through the standard internet breakout. This allows real-time voice traffic to be prioritized.

Network complexities have also increased; consequently, Software Defined Network (SDN) architecture has emerged to satisfy these more complex networking requirements. SD-WAN is a specific application of SDN: being able to manage routing policies through different WAN links enables network configuration optimization. Smart Satellite Services also include SD-WAN compatibility features which introduce a new dynamic to network capability and value-added services.

To ensure the best performance for different user applications, Smart Satellite Services also include advanced service functionality. User expectations vary between different applications; for example, real-time applications like VoIP and video calls are more sensitive to latency and jitter variations; emails and file transfers, much less so. Being able to apply different Quality-of-Service policies for different applications enables Smart Satellite Services to better manage jitter and ensure quality voice and video calls.

A NEW INDUSTRY STRUCTURE FOR SMART SATELLITE SERVICES

With large-scale development and mega-investment projects, a major shake-up of the satellite industry can be expected. Currently, satellite is a niche service and will remain so when compared to mainstream Telco offerings such as fibre, LTE and 5G. It is not a competitor technology to 5G and fibre, but rather an alternative connectivity solution for challenging situations where its unique advantages are applicable - this will remain the case even for Smart Satellite Services.

This has important business implications: from a revenue versus investment point of view, the satellite business is often seen as a case as "too small for the big ones and too big for the small ones". In other words, the business case is not strong enough to interest major Telco's, yet at the same time, the expertise and investment level required is now beyond the reach of the niche ISPs which were previously building and operating satellite networks.

While this creates the perfect opportunity for specialist providers like Q-KON with their Twoobii-on-Flex service, it does have specific implications for end-users. Any network architect or procurement team needs to understand that satellite is a niche service and should be approached with a different design and implementation paradigm.

When shopping for a niche specialist service, you can't expect the big market voices to drive the knowledge discussion. In today's tech-biased world, we generally learn about new technologies through marketing campaigns from leading providers. Very few end users do any research beyond this.

The most important point for buyers to note is that for niche services, brand value does not of itself guarantee success. The major Telco's may still have satellite broadband in

their service portfolio due to legacy developments, yet it is highly unlikely that they will have kept up with the expertise, technology and foundations required to deliver modern Smart Satellite Services.

It follows that Smart Satellite Services need smart satellite network architects, smart satellite implementation teams and smart satellite business models. This is the underlying issue that will drive change in the overall satellite industry and map the route to full adoption of emerging Smart Satellite Services.

LEO and MEO satellite operators may enter local markets as direct competitors to established Telco providers, or support the current industry structure through distribution-type models. Local regulatory requirements and the appetite for risk of satellite network operators will largely determine the path to be followed by each operator. This will certainly lead to a new order and new positioning of Telco providers in the local market – and could well be good news for customers and end-users alike.

CONCLUSIONS

The satellite industry is undergoing major changes with large project investments, new high-power satellites and the development of LEO and MEO constellations.
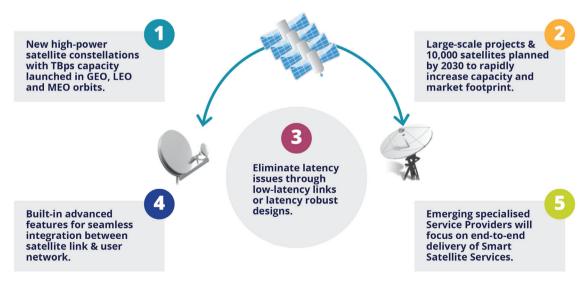
This is driving development in satellite technology and end-user equipment technology and opening the way to new Smart Satellite Services models.

Smart Satellite Services have the performance, features and specifications to enable all current applications including voice and video, and can be seamlessly integrated with SD-WAN and other network architectures.

The ability to apply current and emerging satellite services to unlock markets will be determined as much by satellite features and specifications as by the capabilities and business models of the service providers.

Simply following the old ways by offering satellite services from a pre-set product menu with one-size-fits-all structure will never lead to market success, even with latencies of less than 50msec. wn

Key elements of Smart Satellite Services

1 New high-power satellite constellations with TBps capacity launched in GEO, LEO and MEO orbits.

2 Large-scale projects & 10,000 satellites planned by 2030 to rapidly increase capacity and market footprint.

3 Eliminate latency issues through low-latency links or latency robust designs.

4 Built-in advanced features for seamless integration between satellite link & user network.

5 Emerging specialised Service Providers will focus on end-to-end delivery of Smart Satellite Services.

Powered by Flex from **INTELSAT.** √

© Article courtesy of twoobii

INFRASTRUCTURE 4.0:

Achieving Better Outcomes with Technology and Systems Thinking

Technology adoption is key to enhancing the delivery and performance of infrastructure systems.

BY I JOSEPH LOSAVIO I OLIVER TSAI

The role of infrastructure in society seems straightforward. It provides essential services to our homes. It gets us to where we want to go. It provides a place for learning and healing. To many, infrastructure is a collection of separate assets that we interact with as we go about our day. But infrastructure is so much more. Infrastructure brings power and water to the places we live and takes waste away, allowing us to be healthier and more productive at home. Infrastructure provides access to

economic opportunity, education and healthcare. Infrastructure can bring us closer to nature and help ensure the protection of our natural world.

Infrastructure is more than just a series of assets. It can be a service that improves our lives. It is not just one hospital building, one train line or one network of water pipes. It is a system of systems that links the built environment, the natural world and the human experience. Done right, infrastructure investment has

the potential to help us build a more sustainable, equitable and prosperous world and can serve as a platform that focuses on outcomes that help the planet and its people thrive.

However, the way we currently develop infrastructure has struggled to meet these lofty aspirations. Over-budget, off-schedule and poorly performing projects inhibit infrastructure's ability to serve as an optimal platform for human and natural flourishing. One strategy to avoid these problems is to incorporate
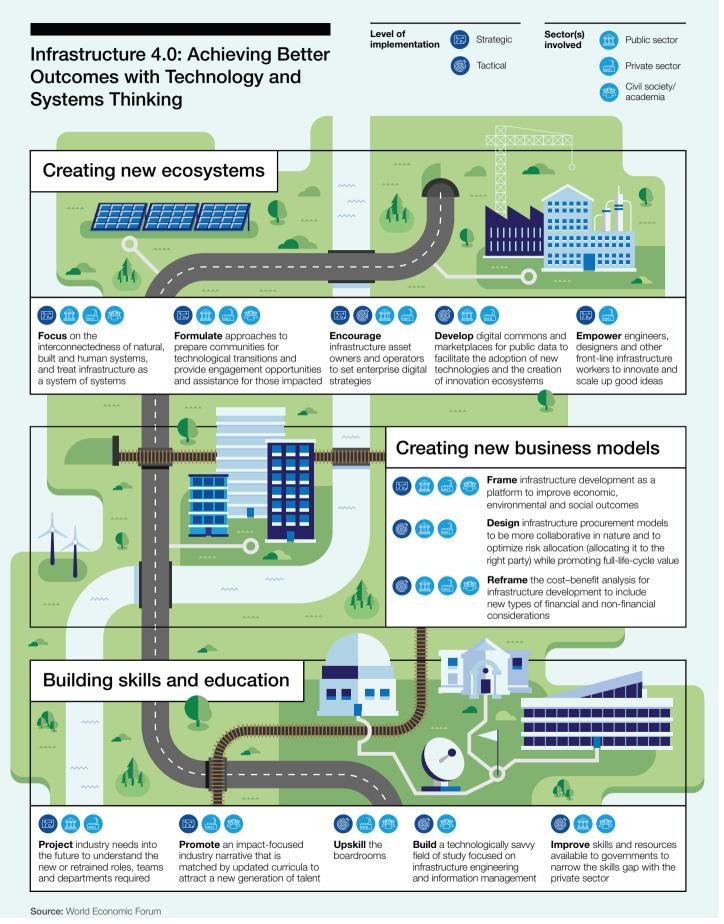
emerging technologies into the way infrastructure is developed. While other industries have wholeheartedly embraced new technologies and run headlong into the Fourth Industrial Revolution, infrastructure has struggled in comparison. Construction, a critical stage of infrastructure development, is the second least digitalised sector in the economy, ahead of only agriculture. This is not due to a shortage of innovation in the space. Indeed, a thriving world of innovators is devising solutions that can revolutionise how we plan, design, procure, construct, operate, and decommission infrastructure.

Technology can be the enabler of high-quality, outcome-focused infrastructure systems, but its adoption across project life cycles needs vast improvement. While infrastructure traditionally moves at a staid pace with projects that take years and assets that last lifetimes, this current technological revolution is outpacing previous ones at an unprecedented speed. Infrastructure is letting this wave of innovation race right by it.

This is not just a problem for those involved in developing infrastructure; it has implications for us all. Infrastructure is key to providing economic opportunity for billions and is a crucial tool for climate action. Both are looming challenges that the world needs to address now. The infrastructure development push likely to follow the abatement of the COVID-19 pandemic will shape the

Infrastructure 4.0: Achieving Better Outcomes with Technology and Systems Thinking

Level of implementation — Strategic — Tactical

Sector(s) involved — Public sector — Private sector — Civil society/academia

Creating new ecosystems

Focus on the interconnectedness of natural, built and human systems, and treat infrastructure as a system of systems

Formulate approaches to prepare communities for technological transitions and provide engagement opportunities and assistance for those impacted

Encourage infrastructure asset owners and operators to set enterprise digital strategies

Develop digital commons and marketplaces for public data to facilitate the adoption of new technologies and the creation of innovation ecosystems

Empower engineers, designers and other front-line infrastructure workers to innovate and scale up good ideas

Creating new business models

Frame infrastructure development as a platform to improve economic, environmental and social outcomes

Design infrastructure procurement models to be more collaborative in nature and to optimize risk allocation (allocating it to the right party) while promoting full-life-cycle value

Reframe the cost–benefit analysis for infrastructure development to include new types of financial and non-financial considerations

Building skills and education

Project industry needs into the future to understand the new or retrained roles, teams and departments required

Promote an impact-focused industry narrative that is matched by updated curricula to attract a new generation of talent

Upskill the boardrooms

Build a technologically savvy field of study focused on infrastructure engineering and information management

Improve skills and resources available to governments to narrow the skills gap with the private sector

Source: World Economic Forum

FIGURE 1: Recommendations to drive progress and innovation in the infrastructure sector

world for decades to come and carry ramifications for generations. It is essential to leverage technology to build a world that is better than the current one.

As countries worldwide try to understand what actions they can take to restart economies after the ravages of the COVID-19 pandemic, many are turning to infrastructure development.

These recommendations in this article are meant to assist decision-makers in business, government, civil society and academia in working together to develop better infrastructure. These recommendations, built with insights from the foremost professionals in the field, can help shape the way we build our infrastructure systems at this crucial inflexion point and ensure we build a world that allows all of us to thrive.

RECOMMENDATIONS

Focused and collective actions by government, industry and civil society are required to drive progress and innovation in the infrastructure sector.

Throughout three general workshops and six working group meetings, project community members explored the critical barriers to adopting emerging technologies and innovation across the entire infrastructure life cycle. The discussions resulted in a list of 13 recommendations that fall under three main thematic areas:
1. Creating new ecosystems
2. Creating new business models
3. Building skills and education

The first theme, Creating new ecosystems, concerns providing an enabling environment within government and private industry to foster greater collaboration and

alignment. The five recommendations in this group seek to align stakeholder perspectives at a high level and encourage a systems approach by breaking traditional silos of engagement both within and between organisations.

The second theme, Creating new business models, aims to strengthen and align market incentives to encourage full-life-cycle decision-making, focusing on the performance outcomes of delivered infrastructure. The three recommendations in this group intend to shift the existing paradigm for decision-makers to account for externalities and non-monetary factors in business case decisions.

Finally, the third theme, Building skills and education, recognise the fundamental truth that change comes from people. Lasting change in policy and practice must rely on the individuals within organisations to buy into and carry out the reforms needed to improve processes and outcomes.

The five recommendations in this group seek to improve the skills and capacity of stakeholders in the present and ensure that training and education for future generations remain flexible and relevant to a rapidly changing world.

1. CREATING NEW ECOSYSTEMS

Focus on the interconnectedness of natural, built and human systems, and treat infrastructure as a system of systems

Our world can be understood as a series of interlocking systems. Infrastructure is but one of these systems that, when connected with

many others, provides opportunities and support to help humans live, essentially transforming infrastructure into a service that connects the built environment to the human world and the natural sphere.

This connection makes infrastructure critical to human success. Reframing infrastructure as one within a system of systems helps to understand how and why infrastructure projects are developed and reorient the measure of success towards how positive outcomes are produced. Additionally, it helps move away from thinking about infrastructure in terms of permanent frameworks to impermanent solutions.

This leads to dynamic infrastructure that better serves people, integrates natural elements, is more resilient in the face of climate change and other shocks, enables solutions to decarbonise the economy, and is more economically successful in the long term. It also helps to recognise that humans are perpetually working towards continuous improvement and that ambition will continually challenge and outpace the status quo.

Formulate approaches to prepare communities for technological transitions and provide engagement opportunities and assistance for those impacted

Historically, technological transitions are hard to navigate, but doing so successfully is a crucial element of technology adoption, mainly if that technology materially changes the way people interact with their community and the built environment.

Governments and businesses must ensure proper consultation

with communities throughout the development process of any infrastructure system, especially if it involves using new technology. Increasing sensitivity related to data privacy is but one example of an issue that must be addressed at a very early stage. Ensuring the user-friendliness of customer-facing aspects of infrastructure systems is another.

The key to this is emphasising the ways communities extract value from technology-enabled infrastructure. Examples include optimising safety and stability day-to-day and during emergencies, increasing access to economic opportunity, and improving commercial, health and educational services.

These approaches require engaging with more than just the community and should include the other stakeholders that interact with the community that would also be affected by the transition. Having government data strategies in place at the local and regional levels would be an enormous help in this regard, and they should be closely linked with national infrastructure plans.

Defining precise methods and goals for why and how governments collect and use data allows governments to more clearly articulate the potential benefits of using new technologies and build trust with the communities they serve. Engaging with communities using transparent frameworks related to technology can help demonstrate that the public's concerns are understood. Clarity is also needed on the strategies for personal data as well as asset and system data.

Communities should be involved in crafting the regulations and policies that will govern the new technologies being used. Providing the opportunity to solicit input and work together across stakeholder groups builds trust, maximising the chance of success. However, governments should be careful not to overregulate to the point of stifling innovation.

Encourage infrastructure asset owners and operators to set digital enterprise strategies

An enterprise digital strategy, a comprehensive business-wide plan focused on using digital technologies to achieve business goals, is essential in ensuring technologically advanced infrastructure systems.

These strategies are essential for survival in a fast-digitalising world, and the quality of the strategy is linked to the degree of success. However, given the importance of taking a system-wide approach, these enterprise digital strategies must also include a shared digital transformation strategy between the owner and the entire supply chain to ensure interoperability.

This is crucial for creating a seamless experience for customers and partners and improving quickly responding to changes. It is also important to note that any system-wide approach should also apply to processes between organisations to improve shared delivery. Digitally transformed organisations with digitally transformed processes lead to digitally transformed systems, which can be a powerful tool if directed towards meeting shared outcomes.

Industry standards would greatly help in this regard, as they have been in other industries, such as airlines and financial services. In the end,

stakeholders must define a strategy, operationalise it and use it to operate in the ecosystem.

When devising these systemic digital strategies, considering varying levels of digital maturity is critical. Organisations with limited digital maturity should focus first on digitalising large parts of the business to optimise core operations, intentionally creating a strategy that takes them from where they are to where they want to be. When devising a comprehensive digital strategy to use digital tools, Mature organisations should realise that they are on an ongoing journey of business improvement. All of this would then be folded into the supply-chain-wide enterprise digital strategy to coordinate efforts.

Develop digital commons and marketplaces for public data to facilitate the adoption of new technologies and the creation of innovation ecosystems

The ability to collect, organise and use data is a vital piece of the puzzle for creating a technologically advanced, flourishing infrastructure innovation ecosystem. Yet this has been a daunting task for many government entities. Local governments, in particular, have generally struggled to find effective ways to collect data consistently and have even more trouble organising and using the data they have to improve performance outcomes. By efficiently and effectively collecting and managing data, governments can facilitate the creation of data commons, which can act as repositories for important infrastructure-related data and code.

These repositories would be open for the use of stakeholders to improve infrastructure design.

To facilitate these data commons, governments must devise national information management frameworks. These are crucial tools for setting rules and creating a "spine" that supports entire information ecosystems. This allows would-be entrepreneurs and inventors access to the data that allows them to innovate and aids owners and operators who depend on a "golden thread of information" (end-to-end records and information for an asset) to plan, build and manage infrastructure properly.

It will be crucial to formulating the proper regulations and policies to govern these frameworks; this should be done inclusively and holistically, involving multiple stakeholders and addressing community concerns. This should include defining standards for data collection, which ensures the data gathered is practical and provides the transparency that is an essential component of building trust in the system.

One crucial element of setting up this properly functioning data and code market is valuing digital assets the same way other assets are valued. Just like any other asset, digital assets should be judged on the cash flow they generate, which requires developing a better business case that provides a fuller range of scenarios for decision-makers. Understanding the value of digital assets improves the decision-making capability around how and when to deploy the assets and provides greater insight on the value of new technological tools in compounding their worth. Very importantly, it also helps to establish a thriving market. However, some balance is needed between the market and non-market aspects of what is shared. This requires collaborating on the rules of the market while enabling competition within it. Digital commons should catalyse a market, and the focus should be on enabling this market, not controlling it.

Empower engineers, designers and other front-line infrastructure workers to innovate and scale up good ideas

In many industries, innovations often come into being on the front line, where problems and disconnects are most apparent to operators and end-users. This is no different when it comes to infrastructure development. Allowing workers on the front line to leverage innovations can improve project performance and help attract a new generation of workers who have become accustomed to integrating new technologies into their daily lives.

It is also critical to provide pathways for employees on the front line to pass improvements and innovations across teams and upward through the levels to help increase innovations throughout organisations. A more digitalised workplace is one strategy that can help improve the ability to undertake this.

2. CREATING NEW BUSINESS MODELS

Frame infrastructure development as a platform to improve economic, environmental and social outcomes

Too often, the conversation on infrastructure is myopically fixated on the specific project itself and mainly focused on the details of design and construction and the immediate need the asset is meant to serve. Instead, the conversation should be reframed, stressing not the physical infrastructure asset but how the asset serves people and nature to ensure that the built environment, natural environment and human world can work together as an optimised system of systems. Planning, designing, building and operating infrastructure should emphasise meeting economic, environmental and social outcomes.

Technology is a crucial enabler of these outcomes and, if used wisely, can vastly improve them. Innovations should not be selected solely for the sake of exhibiting exciting technology in a project. Technology should be thoughtfully applied to enable better results, a tool with a defined role in delivering better outcomes. Four key questions can determine whether the use of technology is value-driven:

1. Can I improve the asset's current capability?
2. When I build, can I build it better with technology?
3. Can I fundamentally disrupt demand?
4. Can I use technology to disrupt the need for the asset altogether?

Stakeholders who have a hand in making significant decisions about projects have an essential role to play here. This includes governments and owners who define minimum specification and performance requirements, institutional investors who own concessionaires, and developers who want to push the bar higher than the minimum requirements.

The details of a project (e.g. what form the asset will take, what materials and methods will be used, what the asset function will be) are often left to project owners. They can take this opportunity to be explicit about capabilities and

project needs and the outcomes it aims to produce, which can help push for more innovation.

During the procurement phase, laying out preferred outcomes, rather than being highly prescriptive, can source a whole range of new ideas that inject the process with innovation. However, some elements of standardisation are essential to expanding innovative infrastructure approaches.

Design infrastructure procurement models to be more collaborative and to optimise risk allocation (allocating it to the proper party) while promoting the full-life-cycle value

The procurement process for infrastructure development has often encouraged an adversarial atmosphere between partners. A lack of coordination and cooperation has been a significant factor in the inefficiency of project development and the frequency of cost overruns that plague projects large and small.

Outcome-focused, collaborative delivery models are emerging that are more capable of dealing with complexity and allow effective integration with existing systems. Such models leverage input from across the supplier ecosystem, bringing together engineering and technology to deliver intelligent solutions. In these models, the role of procurement is to acquire the capability to achieve the outcome rather than to secure services based on the scope of work. Additionally, the risk is allocated according to each stakeholder's capability to manage and, where possible, the risk is jointly owned rather than transferred down the supply chain.

While the suitability and integration of these models will depend on the specific context in each jurisdiction, including available sources of financing, they can be an essential tool. They facilitate integration around the outcomes and align the project supply chain with these end goals.

They bring parties together for a more holistic process that strikes a balance between competition and cooperation and can lead to better project outcomes all around. Aligning all parties on common outcome-based goals also makes it easier to introduce and demonstrate the value of new technologies across the entire life cycle, compared to the traditional approach of evaluating proposals separately at each distinct stage of a project. However, it is essential to note that the public-sector level of expertise and capacity are important factors when considering collaborative models. In most emerging markets, collaborative models can only realistically be implemented with the guidance of competent and experienced advisers. Capability may also be an issue even in developed markets.

For instance, in some European countries, infrastructure agencies have lost the technical expertise needed when the focus for infrastructure development has shifted from traditional contracts to integrated performance-based contracts, including public-private partnerships.

This type of organisational experience is required for infrastructure agencies to procure, tender and manage contracts effectively, particularly performance-based, outcome-focused and collaborative, where risks are shared and managed adaptively.

Aside from the need to leverage newer models, improving communication between owners and operators is also important to focus on outcomes, reducing the likelihood of costly mistakes. Additionally, more efficient dispute resolution mechanisms help reduce time and money spent on project development.

It may also help to think about which types of incentives can be introduced to improve value capture, pushing project decision-makers to procure outcomes and promote full-life-cycle value. More innovative thinking is also needed on how infrastructure assets are combined with other value-capture models and growth platforms, a common strategy for infrastructure development in East Asia.

Reframe the cost-benefit analysis for infrastructure development to include new types of financial and non-financial considerations

Risks for infrastructure projects have traditionally focused heavily on a relatively narrow scope of financial considerations. Attention should shift to other emerging risks, like cybersecurity and climate resilience, which should be included in an expanded definition of financial risk.

This conversation should also encompass the entire life cycle of an asset to ensure that the costs, benefits, risks and mitigation are correctly matched with current trends and desired outcomes. This new approach to risk should also be twinned with defining the ways emerging technologies can help mitigate these risks and provide new benefits in both financial and non-financial ways. To help ease

concern over adoption, leveraging new technologies should be thought of in terms of risk and uncertainty. It is essential also to emphasise the benefits technology creates, which will help attract attention from project developers, sponsors and financiers.

One way to understand what parameters these new cost-benefit analyses should include is to use existing global frameworks, such as the United Nations Sustainable Development Goals, as a basis. The appetite for environmental, social and governance (ESG)-related investments is increasing. The door to genuine ESG capital could open if frameworks that deal with topics like climate risk and social considerations are used to assess infrastructure projects.

3. BUILDING SKILLS AND EDUCATION

Project industry needs into the future to understand the new or retrained roles, teams and departments required

Before an industry can fully embrace innovation on a large scale, it must understand how its workforce must change. As regards integrating new technologies, skills and competencies of human capital are often more important than the technology itself.

What can employees do to improve a business with a given piece of technology? The first step is to apply a forward-looking lens to understand the future needs of a technologically enabled organisation, often with the help of partners in academia and professional industry associations and accrediting organisations. These crucial allies can help ensure that learning occurs at all career stages and that relevant accreditations and credentialing standardise employee training practices.

It is crucial to delineate the specific competencies required to leverage emerging technologies to build teams around them. This creates the space for companies to match their workforces with the needs of the future. However, implementing these steps varies in difficulty, depending on where one sits in the value chain.

For example, for infrastructure operators, the incentive to retrain employees is clear, with relatively distinct upfront benefits. However, for contractors, the decision to reskill workers requires rethinking the business strategy and return on investment that takes longer to become apparent. To assist with this, making these training and upskilling programmes work in tandem with the overall digital transformation could be helpful. It is also essential to ensure that technical onboarding training is cross-disciplinary to break down silos.

Promote an impact-focused industry narrative that is matched by updated curricula to attract a new generation of talent

Infrastructure developers have a compelling story to tell. Infrastructure is key to winning the fight against climate change, setting cities and countries up for economic success, and ensuring that the built environment, society and nature are connected in an equitable and just way. There are many bottlenecks on the journey from government policy commitments to implementing plans that achieve tangible impacts towards Sustainable Development Goals. Engineers have a unique role in closing the implementation gap and operationalising these goals.

In alignment with a more outcome-focused model for developing infrastructure and understanding infrastructure's place within a system of systems, companies should promote their role in helping build a better society. Companies should highlight their role in creating better outcomes for society and focus on infrastructure's part in addressing issues like the environment, economic inequality, and social equity. It is also important to acknowledge the externalities of industry activities and ensure that transparency and accountability are practised.

Academia should work hand in hand with industry when building programmes to guide graduating students into the field. It should motivate and inspire by emphasising the broader effect of infrastructure development on the world and working with professional bodies to ensure that curricula are agile enough to remain relevant in an industry that fully embraces change.

Upskill the boardrooms

One of the essential steps is convincing senior management that integrating technology at all levels is imperative. This means teaching senior executives the value and importance of adopting technology across infrastructure system life cycles. In practice, this includes instilling an understanding of the importance of data maintenance and usage in management. This can involve hiring a chief data officer to unite the IT and data components of the business, lead internal digitalisation efforts and coordinate enterprise digital strategies. This can also be

done by diversifying corporate boards to integrate technology-focused voices and ensure the highest levels of the organisations remain on the leading edge.

Companies should also use reverse mentoring to improve tech knowledge from the front line upward. It is often the fresh-from-university, new-to-the-job employees that have a natural handle on the latest technologies disrupting the business. Connecting them with other employees in the organisation, particularly at higher levels, can help disseminate technological know-how throughout a company.

Build a technologically savvy field of study focused on infrastructure engineering and information management

Helping prepare students for a technology-forward, the outcome-focused industry is crucial. This effort should include building ontologies (a set of concepts and categories that can help to understand a subject) and studying information quality management and encouraging the application of systems-thinking strategies.

The skills needed to manage information are the same across infrastructure sectors, yet information management is a missing process for most organisations. Practitioners know how to use technologies, but they have little understanding of the underlying data models and protocols.

There are insufficient study programmes that incorporate skills in data and information management, which would enable organisations to develop the capabilities to put required processes in place.

The authentic "infrastructure" programmes at universities are few, and many are heavily focused on engineering rather than information. Holistic programmes are needed that emphasise the role of infrastructure in meeting outcomes and the planning, management and delivery aspects of infrastructure where information is the primary product.

They should include topics like ESG issues, information quality management, political and policy analysis and economics. Ideally, this would start at the bachelor's degree level, focus on technology as an enabler, and complement technical science with behavioural science.

Additionally, innovation centres that bring together academia and the private sector can help bolster this field of study. A new discipline of professionals in infrastructure information is required, integrating infrastructure and information management disciplines and enabling infrastructure development for the public good.

Improve skills and resources available to governments to narrow the skills gap with the private sector

The private sector is at the leading edge of innovation and technological change, and there is often asymmetry between knowledge, skills and capacity in the public and private sectors. Ensuring governments can utilise new technologies is critical to ensuring that investment in these technologies is successful.

Unfortunately, governments cannot often leverage technology and structure procurements that encourage its integration. The assistance should be

provided to government agencies that need help. Multilateral development banks can play a role in bridging this public-private sector gap by providing technical and financial assistance.

Planning knowledge-sharing opportunities between developed and developing countries is also an excellent way to build capacity. Finding ways to bring in outside experts from other countries could help mitigate the issues of low-salaried government employees leaving for other opportunities once they have acquired new skills. However, with this spirit in mind, it is essential to remember that every country is different, and homogeneous solutions must be avoided. One size does not fit all.

To drive transformation in government, a focus on organisational change is also needed, in addition to individual growth. Government officials and practitioners come and go, both as political appointees and career bureaucrats. Working towards change throughout an organisation ensures long-term success in developing policy-maker experience with key technologies like building information modelling (BIM) and digital twins.

CONCLUSION

As the world recovers from the pandemic, the upcoming infrastructure boom presents a window of opportunity to make critical improvements that will affect generations to come.

These recommendations can guide decision-makers through a new era of global infrastructure development to ensure that the infrastructure built is technologically enabled, focused on improving outcomes for the people and the planet, and anchored within a system of systems.

Given the long lifespan of typical infrastructure systems, decisions made today will chart the path for our planet and its people for generations. That is why it is so essential to implement these recommendations at this critical juncture. At the beginning of this upcoming global infrastructure boom, integrating these ideas increases the chances of their success and, in turn, the quality of the infrastructure built.
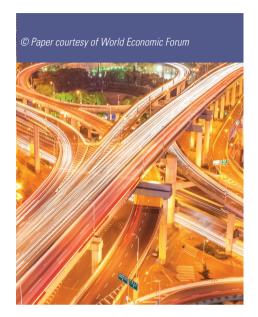
These recommendations are meant to be shared within boardrooms, government ministries, classrooms – everywhere where the future of infrastructure is debated. Existing and planned initiatives that support these recommendations are welcome, as is continued input on the utility of the recommendations as the infrastructure technology environment evolves.

This White Paper marks a milestone for the initial phase of the Infrastructure 4.0 project, which will be followed by a call to action to translate these recommendations into impact.

The Infrastructure 4.0 project community will continue to explore solutions to the issue identified and work towards its own set of implementation strategies and work with the World Economic Forum's network to make sure these global recommendations are disseminated for practice at a local level.

It will also continue to work with the Global Infrastructure Hub to highlight best-practice examples of technology adoption throughout infrastructure project life cycles. By using technology as an enabler, with a focus on improving outcomes for people and nature, it is possible to ensure that infrastructure serves as a platform to connect the built environment, the natural world and human lives in a way that allows all three to thrive. **wn**

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DIGITAL TRANSFORMATION:

5 Critical Considerations for Successful Strategic Rollout

As the world begins to emerge from a yearlong lockdown, businesses are now assessing not only how they have navigated the challenges faced throughout the pandemic but how they can ensure that their businesses remain insulated from any future catastrophe on the scale of COVID-19.

The key to achieving this insulation is achieving digital transformation within these businesses. Customer adoption of digital channels across the globe has been nothing short of seismic throughout the past year, and it has left businesses of all sizes and in all markets grappling with the challenge.

With many challenges at play in achieving digital transformation, we have identified five key areas to focus on to launch your organisation on its digital transformation journey.

REVIEW AND IMPROVE YOUR BASELINE SYSTEMS

To achieve both the business's commercial goals and allow the business to engage with their customers in the digital channels of their customer's choice, a primary assessment of the existing enterprise's technological ecosystem is a critical first step.

Does the current technical landscape allow you to scale, communicate and analyse?

ENSURE YOUR FRONT-END WEB ASSETS ARE EFFECTIVE

With the mass customer adoption of digital channels witnessed throughout 2020 and the emergence of the digital native Gen Z as crucial players in the global consumer base, user experience and user interface has never been more important to consider for any business' web assets genuinely effective.

DESIGN AND AUTOMATE A STRATEGIC DIGITAL COMMUNICATION PLAN

Does your business have a strategic digital communication plan? If not, that's your starting point; if yes, how are you structuring and deploying it? The installation of a Customer Relationship Management system to execute your communication strategy, artificial intelligence to segment and build behavioural profile models, and automated workflows to execute the communication pillars through selected digital channels are critical elements.

UNIFY AND VISUALISE YOUR DATA SOURCES

Build a unified view of your business and your customers. Traditionally, this is the one element of digital transformation that holds the most fear. It shouldn't.

Having gone through the initial assessment path of your current technological environment and with the ever-growing landscape of software providers utilising open-source methodology, unifying data sources has never been easier to achieve.

ADD WONDER THROUGH IMMERSIVE DIGITAL EXPERIENCES

With the increased demand from consumers for hyper-personalised interaction with businesses and brands, creating an immersive digital brand, product or service, customer experience can give businesses a real competitive edge. Augmented and virtual reality technology and holographic technologies are no longer elite products and can be deployed across many digital and social channels to drive extraordinary experiences for your customers.

INTRODUCTION

It was pretty extraordinary, given that many of them had a limited digital presence before the COVID-19 outbreak.

Seen as one element in a digital transformation program that was still being built, discussed and planned internally, the sudden need for execution quickly surpassed the need for planning and solutions were quickly deployed. In one conversation, a client executive lamented that their expertly designed digital transformation program, which had a three-year roadmap, had been torn up, and the execution roadmap was revised to six months.

Over the past thirteen months, through deep experience working closely with business leaders under extreme pressure to execute digital transformation programs (in their entirety or a phased execution model); we have identified the five key considerations for businesses and their leaders to assist them in achieving the digital transformation goals for their organisations.

More importantly, the team has identified the one consistent element that will dictate your organisation's success or failure in achieving true digital transformation.

This article will lead you through the critical elements to consider when engaging in digital transformation and what to plan to ensure the program's success.

REVIEW AND IMPROVE YOUR BASELINE PLATFORMS

Ensure that business support has been provided through various industries and geographies in their respective digital transformation journeys.

From each of these departure points, it may surprise you to learn from each of these businesses; from global blue-chip to medium-sized enterprises, the primary issue at the outset is almost always the same—their existing technological ecosystems.

We have set out with global brands who managed client interaction on excel spreadsheets and medium to large-sized enterprises who kept critical commercial data in multiple external hard drives. Fragmented, disjointed, and not fit for purpose. If you are about to embark on a digital transformation journey (or you are in the midst of your journey), this should be your starting (or re-starting) point.

Your technological ecosystem should serve at least three purposes for your business; it should be scalable, allowing all channels to be unified, and deploy automation for strategic customer communication.

While this may seem pretty obvious, it is incredible to see how many businesses sit with a technological ecosystem simply because of a legacy mindset (it has worked for us in the past, so why change it?); or out of fear (how much will it cost? How long will it take? How will it work? etc.).

In all of the discovery processes we have undertaken over the past thirteen months, 95% of our clients were required to change one or more of their baseline platforms to achieve the digital transformation their business required.

The key here is a mindset. Digital transformation should be communicated internally as a substantial commercial opportunity and not an enormous task clouded in fear and uncertainty. This is your opportunity to future-proof your enterprise, and it doesn't need to be complicated. But it does need to be built on sound foundations.

THE KEY QUESTIONS TO ASK WHEN REVIEWING YOUR BASELINE PLATFORMS ARE:

1. **Are your platforms scalable to serve your business in its growth goals?**
   In the discovery process of a digital transformation program for one of our large retail clients, we found that their e-commerce store was built from a WordPress template with a WooCommerce plugin to allow online purchasing, which is a perfectly suitable platform

CRITICAL TO ANY BUSINESS IN THE MODERN AGE IS TO HAVE THE CAPABILITY TO SEE THE BUSINESS IN A 360-DEGREE VIEW, IN REAL TIME.

for a small enterprise with low customer touchpoints and even lower business data sources. But for a retail business with over seventy high street stores, a thriving wholesale business and an aggressive growth plan to 2025, it wasn't fit for purpose to serve the commercial and operational needs they had.

The platform was deployed for speed during the outset of the COVID-19 pandemic and not through strategic planning. Deployed out of necessity and not design.

2. Can your current technology stack be unified into one viewpoint?

Critical to any business in the modern age is to have the capability to see the business in a 360-degree view in real-time. How you achieve this is by taking all of your commercial, operational and sales technologies and unifying them into one viewpoint to allow the business to function with less risk and allow its leadership to make more strategic and more agile decisions for the enterprise's benefit.

It is also important to note here that seeking a review of operational processes when assessing the unification ecosystem is critical. For example, a large manufacturer supporting their digital transformation journey had an existing technology stack that was easily unified through an integration process via an API that we would build for them. But in reviewing their operational processes in tandem with this assessment, we found that their

e-commerce image library data was being stored in external hard drives. No redundancy plan existed to de-risk the business should one of these hard drives corrupt or was lost. Deploying a Digital Asset Management (DAM) system into their technology stack and unifying it with the rest of their platforms was a non-negotiable move. The operational and procedural change goes hand-in-hand with any organisation's digital transformation journey.

3. Do your platforms allow for strategic customer communication and automation?

An excellent starting point here is asking yourself this question first; 'do we have a strategic customer communication strategy?' The answer to this question with over 70% of our digital transformation clients is no. It can be hard to fathom, but it is the reality from our experience. As a business grows and becomes more complex through various service or product offerings and new markets, it is easy for many businesses to lose sight of the basics.

We've seen single owner-managed drop-shipping e-commerce web stores with a more sophisticated automated communication strategy than multi-national blue-chip enterprises. A large B2B client of ours, who serves some of the world's biggest brands globally, did not have any strategic communication plan for their existing clients outside of sporadic emails for reactive purposes. They have a deep faith in their client services team's ability to engage their various clients in their various

markets (managed on an excel spreadsheet).

By deploying a Customer Relationship Management (CRM) software into their business and by designing and executing an Account-Based Marketing (ABM) strategy for them (with automated workflows), they are receiving 33% higher interaction and engagement with their clients than in the previous two years.

Deploying a CRM system to drive strategic communications to your customers; together with automated workflows and artificial intelligence tools to segment and model customer behaviour for your enterprise will revolutionise the business as a whole.

Once you've identified the platforms that can continue to serve your business and the new systems and processes that will need to be introduced to the ecosystem, the journey can truly begin at pace.

ENSURE YOUR FRONT-END WEB ASSETS ARE EFFECTIVE

As we move forward in a world that has seen significant mass adoption of digital services over the past months through the COVID-19 pandemic, and as a new generation of digital natives become more prevalent in the global consumer base, the effectiveness of your web assets has never been more critical.

In our software development business, we employ a 'Four D' execution model that is (i) discover, (ii) define, (iii) develop, and (iv) deliver. As laid out earlier, it is critical to go through a comprehensive discovery process to understand your business's current

75% OF CUSTOMERS BASED THEIR ENTIRE PERCEPTION OF A COMPANY'S CREDIBILITY ON ITS WEBSITE DESIGN

88% OF CUSTOMERS WOULD NOT RETURN TO A WEBSTORE FOLLOWING A BAD EXPERIENCE

technical and digital landscape, but assessing your existing web assets for effectiveness and improvements is also critical. For us, this is the 'define' element of our development model.

User experience (UX) and user interface (UI) design in web assets is no longer an option for businesses today; it is an expectation. Enterprises who fail to invest in the effectiveness of their web assets will lose customers, and eventually, market share. To cement this point, a 2021 survey out of the US found that 75% of customers based their entire perception of a company's credibility on its website design and experience, and 88% of customers would not return to a web store following a bad experience.

In our previous whitepaper, The Great Reset of Our Time, we had identified a new and extreme urgency for digital transformation. We have now seen that this urgency has driven many businesses to serve the urgency of their need to digitally transform, rather than serving the needs of their customers to transform their businesses to provide the experience that the customer now requires. In

the previous paper, we also noted a demand for more hyper-localised and hyper-individualised communication from customers, and the experience of your web assets is not precluded from these customer desires and demands.

When assessing your current web assets, re-look your businesses requirements today and push back against any temptation to rely on legacy thinking. Interrogate all. Spend time on new market research, on new value propositions for existing products or services. Create new user personas for your customer base and test the user journeys within your web assets. Engage with UX and UI experts to support you in this process. It is critical to truly digitally transform your business to give your customers the best and most practical experience of your digital world.

DESIGN AND AUTOMATE A STRATEGIC DIGITAL COMMUNICATION PLAN

A key element to the digital transformation process is communicating, as a business, through digital channels. This is true of both external and internal communication

methods. From a sales and marketing perspective, the holy grail of digital transformation is to achieve a complete omnichannel execution for the business where you provide a wholly consistent customer brand experience in whatever channel they engage. You achieve a fully integrated back-end of all data sources to build a complete 360-degree view of every customer. And while we understand that this is not always achievable due to budgetary constraints for many businesses, not building a strategic communication strategy for digital conversation is a dangerous omission for any enterprise seeking transformation.

It can be a testament to legacy mindsets within businesses to see business leadership vocally accept that the world has fundamentally changed in adopting digital channels for customers but attest that their businesses, customers, and region have not. That somehow, they have been spared this paradigm shift that the rest of the world is subject to. It is somewhat of a phenomenon.

The world has changed dramatically—all of the world. Every business is now

required to have conversations with their customers in the channels their customers prefer. And globally today, more than 80% of customers prefer to converse with businesses or brands digitally (social media, email, chatbot etc.).

To move your business forward in its transformation program, deploy a CRM system immediately (if you don't already have one in place); and ensure that the selected technology can be integrated into all digital channels where your customers engage (social media, emails, SMS, WhatsApp etc.); and that you can deploy AI across the databases for analysis.

Once you have selected the desired CRM tool; design and develop your crucial communication strategies (email and SMS workflows for e-commerce; ABM strategies for B2B communication etc.), and then build and automate the workflows within the CRM system. The key to the successful deployment of your communication strategy is continuous analysis. Split test everything from the outset to add continual improvement week on week and month on month. Be agile and ego-less in the execution, and your customers will appreciate it, and loyalty will build.

UNIFY AND VISUALISE YOUR DATA SOURCES

In our whitepaper, The Great Reset of Our Time, we identified that one of the critical considerations for businesses in 2021 would be the unification of their data sources. Not only is it a key element to achieving digital transformation, but bringing all data sources together will ensure accuracy and insight for your business and for the customers you serve. It is also the only proper way of ensuring the

efficiency of budgetary deployment. Data unification, together with innovative tools, will also allow you to anticipate your customer's needs and communicate to them within their preferred channels. All data sources brought into one destination will drive agility, efficiency; but most importantly, innovation.

Above and beyond the unification process of all of the data sources within your business, you must layer a data visualisation and analysis tool over it. Data, in and of itself, is not very useful. It is the analysis of that data, the ability to visually see the data and drill into the detail that allows a business to make critical strategic decisions to drive the business forward.

Of all of the challenges that an enterprise may face in its pursuit of digital transformation, this one, in our experience, holds the most fear for business leaders. But it shouldn't. Suppose you have gone through the assessment process of your current technology stack - in that case, have selected existing software partners who are fit for purpose and new partners to add to your new future-proof ecosystem. Integration of all data sources is very achievable. Also, with the ever-growing landscape of open-source methodology for software providers, integrated digital ecosystems (Operational, Finance, Web, Sales and Marketing & Human Resources) has never been easier to achieve.
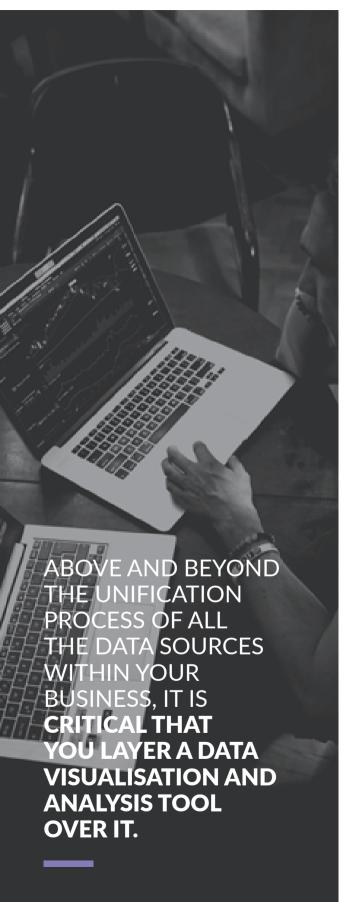
A critical consideration here is that should you decide to select a supply partner to support you in this data integration process, it is generally best practice to utilise the same partner for the initial assessment process. Otherwise, you will have two

partners engage in the same discovery process, which will increase cost considerations. So, as you plan the assessment phase in the early stages of the transformation journey, do so with the end unification milestone front of mind.

ADD WONDER THROUGH IMMERSIVE DIGITAL EXPERIENCES

A new phrase has been coined due to the effects of the COVID-19 pandemic on the traditional advertising methodologies. That phrase is 'Phyigital.' In a world where proximity to a stranger drives anxiety, trial campaigns of test products need to be highly sanitised. Brand activators must remain socially distanced; the appetite for immersive and disruptive digital experiences to replace the traditional physical experiences has increased significantly.

Augmented reality (AR), virtual reality (VR), and holographic experiences (HE) has traditionally been seen as a highly high-ticket item and therefore has been assumed to be too costly an execution for most businesses. Whether that may or may not have been the case in the past, it is certainly not the case today. Immersive experiences have become almost mainstream, and the cost considerations are comparatively no more or less than traditional physical activations, events, or customer engagement strategies. Our activations teams traditionally would have physically activated in a shopping mall. We now place highly interactive digital screens driven by the customer's cell phone to drive brand engagement. Touchless and risk-free. Our retail team would historically deploy beautiful pieces of work inside the retail store to entice customers to pick up a product. Our

development team creates beautiful AR experiences from the retailer's e-commerce store to drive engagement and conversion.

Every business today has the opportunity to drive real and beautiful digital experiences from their web assets, e-commerce store, social media channels, and email communications to customers or employees. When recently presenting a concept to a client in the UAE for a digital brand activation campaign, our concept was met with amazement. Yes, the concept for the campaign was compelling, but every piece of technology used in its execution was eight years old or older. Immersive technology is not new, but a small to medium-sized enterprise's ability to access and afford it is.

Once you have assessed your current platforms, assess your web assets' effectiveness and define what your customers expect as an experience with you and your products or services. Have laid out a strategic communication model to speak to those customers in their channel of preference (while continually analysing their behaviour patterns to optimise that strategy). Have set in motion the unification of all of your technologies and channels to have a total view of your business and customer; why not add an immersive element to enhance the experience your business provides? It's never been easier to do so.

It would seem strange for us to state that the digital transformation of any business was not about technology, and yet, here we are saying precisely that. We have been fortunate to have been part of many digital transformation programs over the past thirteen months. The truth is that all of the programs that failed to reach their goals failed for the same reason – organisational change management. Or, in a nutshell, buy-in.

The human element of digital transformation holds more risk than any technology possibly could. Technology is programmed. It simply can or can't do something, and when you have assessed and selected those technologies, they will, generally, perform exactly as expected. Human beings, not so much. When we analysed this phenomenon within our client base, we decided to cast the net a little wider. We were astounded to find a US-based survey of CEOs, directors and senior executives from 2019. Within that survey, digital transformation was identified as the number one risk to their businesses that they all had identified. However, 70% of their digital transformation programs did not meet their goals and, in a year where $1.3 trillion was spent on digital transformation programs, an estimated $900 million was wasted. Why? People and buy-in.
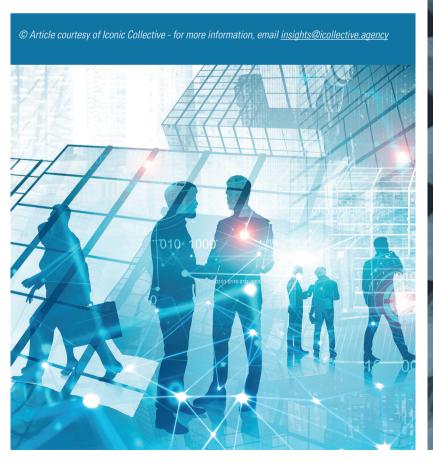
As we've said, technologies will always do the job they were created to do; but even the best-integrated systems will only go so far. These systems can only provide the possibility of achieving your goals. Still,

ABOVE AND BEYOND THE UNIFICATION PROCESS OF ALL THE DATA SOURCES WITHIN YOUR BUSINESS, IT IS **CRITICAL THAT YOU LAYER A DATA VISUALISATION AND ANALYSIS TOOL OVER IT.**

if the mindset of the people within the business is not engaged and supportive of these goals, and if the current organisational process and procedures are flawed, a digital transformation program will magnify those flaws.

If you intend to plan, execute, or re-execute a digital transformation program for your business, human consideration is critical to its success. Manage the narrative, the internal communication strategies, the business champions within each department exceptionally closely. In our experience, where a business has failed to engage the broader business in their planning and tried to achieve their digital transformation goals in isolation, they all failed.

Digital transformation is for all businesses, requiring all businesses to be engaged to achieve it. **wn**

80%
OF CUSTOMERS PREFER TO CONVERSE WITH BUSINESSES OR BRANDS DIGITALLY

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70%
OF THEIR DIGITAL TRANSFORMATION PROGRAMS DID NOT MEET THEIR GOALS

$1.3 TRILLION
WAS SPENT ON DIGITAL TRANSFORMATION PROGRAMS

$900 MILLION
WAS WASTED IN 2019

Technology Futures:

PROJECTING THE POSSIBLE, NAVIGATING WHAT'S NEXT

The new technologies of the fourth industrial revolution, such as artificial intelligence (AI), cloud computing and robotics, are changing how we live, learn and do business at a rate unprecedented in human history. This seismic shift is playing out in a world characterised by unreliable political landscapes and increasing environmental instability.

The global crisis caused by COVID-19 has compounded the challenge that leaders face in trying to plan with conviction – the future feels more uncertain than ever. It is imperative, then, that the people responsible for plotting our collective course forward can access tools that offer them a better understanding of the possibilities that life beyond the near future holds.

BY I MIKE BECHTEL I RAQUEL BUSCAINO I LUCAS ERB I AMY GOLEM I RUTH HICKIN

DEFINING THE FUTURE

The Oxford Dictionary of English offers nine distinct definitions for the word "future"; some are rather pedestrian ("the time that will come"), others more deterministic ("what will happen"). People, too, use a diverse set of words to describe their sense of the future. Many will tell you that it is "clear", "transparent", and "entirely predictable"; others see it as "opaque" and "unknowable" – to them, time and energy spent divining the future feels like folly.

In this article, we argue that neither picture is accurate. Indeed, we see the future as translucent, a collage of intriguing shapes and shadows, but few fine details. This perspective is grounded in futurism (the study of the future), a strategic discipline that can help set a more intentional course towards tomorrow, using practical insights to help dodge oncoming headwinds.

Another of the Oxford Dictionary's definitions for the future, "the possibility of being successful or surviving at a later time", perhaps best describes the territory that we explore in this report. In the following pages, we examine several possible future scenarios and identify where and how technology might play a role.

We want to help you consider which technologies will be relevant to your organisation in the future – not only in the next few years but in the next decade and beyond.

1. A BRIEF HISTORY OF THE FUTURE

Looking anew at the history of computing uncovers structural patterns that help us better see our digital path forwards.

In the 1940s, recognisably modern forms of information technology were anything but ubiquitous. The earliest digital computers were exceedingly difficult to use and were almost exclusively the province of men in white lab coats. ENIAC - by most accounts, the first general-purpose digital computer - was "a monstrosity" that weighed nearly 27 tonnes and filled a 50-foot- long room.

Able to calculate 5,000 arithmetic problems per second, this mechanical oddity was formally debuted in 1946. Press reports at the time proclaimed the dawn of a new era of "giant, magic brains". These brains, amusingly primitive by today's standards, were first put to work on rarefied matters of nation-state security, such as calculating artillery firing tables.

At the time, technologists and even entrepreneurs were notoriously conservative in their estimations of the eventual reach of their creations. IBM chairman and Chief Executive Officer Thomas J. Watson Jr. is often cited for a statement he reputedly made in the early 1940s that predicted: "a world market for about five computers".

Certainly, PhDs with punch cards did gradually give way to professionals with printers. Enter Moore's Law, the semi-famous assertion made in 1965 by research engineer Gordon Moore that, thanks to the transistor, computing power (and cost) would double (and halve) every two years. By the mid-1990s, Moore's Law was proven by computers being in the hands of the majority of the developed world's working professionals. Fifty years after ENIAC first started to crunch numbers, "24 million Americans [were] using a home computer for some personal or work-related task".

It seemed that modern information technology had truly arrived. That is, until Robert Metcalfe, 3Com co-founder and networking pioneer, demonstrated that the usefulness of a computer system is proportional to the square of its number of users. In simpler terms, Metcalfe's Law helped predict the next act in this unfolding technological drama: the development of the internet. Now two steps removed from their academic arithmetic origins, computers had become the global substrate for humanity's higher-order aspirations – calculation had taken a back seat to connection, creation and commerce. By 2010, an estimated 30% of the world's 6.9 billion people were online. Clearly, information technology had reached its destination.

A decade or so earlier, George Gilder, economist and investor, had noticed that bandwidth was growing at triple the rate of computing power. Gilder's Law foresaw what the driver would be for the mobility revolution that helped define the first decade of the 21st century. In the years between 2000 and 2010, we witnessed the move from "America online" to "everyone online" to "everyone online, everywhere we go". Sit-down click-and-type gave way to on-the-go touch-and-swipe, and for better or worse, everyone was now always-on and always connected. End of the line, right?

Not even close. The journey doesn't end with everyone online. The last few years have been marked by an explosion of connected "things": smart speakers, thermostats, doorbells, vacuum cleaners, etc. As of 2019, the average US household had over 11 digitally connected devices, but only 2.6 people. While no one has attributed this latest wave of change to

a particular "law", early returns would suggest that the proliferation of robot roommates is set to continue.

But isn't this report about the future of technology? It's a fair question. Why are we looking back when our objective is to peer forward? As it turns out, futurists are closet historians. We look back to make sense of our journey to the present and, more specifically, to plot the trend lines that can help us chart our course towards what might be coming next. So, what insights can the brief history we've given above offer?

Firstly, that the future is still coming, it's worth noting that reports of the death of technology as a critical business and societal catalyst are, and have always been, greatly exaggerated.

We tend to look back at the achievements of our predecessors with a curious mix of reverence and hubris. Reverence for what they were able to achieve with so little in the way of affordances and understanding; hubris in the self-affirming tone we adopt when we highlight our comparative superiority.

This same pride is what leads us to discount the inevitable future achievements of our successors. It is easier and more comfortable to assert that we have primarily "arrived". Our pride of place makes it singularly challenging to conceive ourselves as the unenlightened actors in some future author's history. It's human nature to crave exceptionalism, to feel as though we are the ones who've finally figured it all out, that we are the cohort uniquely privileged to live in what Francis Fukuyama famously dubbed "the end of history". It's clear, though, that we're no more or less

unique than our predecessors or our successors through the long lens of history.

The future is coming faster. The second takeaway is that the duration of these waves of change is shrinking. The lab-coat mainframe era lasted a good 30 years; the minicomputer/microcomputer era, 20; internet 1.0 changed the world in 10, and digital mobility changed it all over again in just five. Any useful taxonomy of technological change shares the following tenet: technological progress follows the exponential function or, expressed another way, that the tempo of technology-driven change is accelerating.

The word "exponential" often raises resting heart rates. For many, it recalls the anxiety of bygone maths exams. However, those in the know may get anxious because they understand that exponents quickly get out of hand. It is hard enough to get conversant with a bucket-load of new buzzwords, let alone face the looming dread that next year's bucket of neologisms may be that much more profound.

Then, it is no surprise that when faced with this disorienting feeling of "future shock", many civic and business leaders cross their arms, lower their sights, and remain stubbornly in the strategic present. Better, perhaps - they think - to focus today's time on the practical and tactical than on the fuzzy and fractal?

However, any self-respecting strategist would say that this should not be treated as a simple case of "either/or". A Japanese proverb also warns against taking a binary approach: "Vision without action is a daydream. Action without vision is a nightmare."

And therein lies the challenge: how can we efficiently attain enough vision to maintain an informed action orientation?

Thankfully, there is a calmer and more constructive means of sensing and making sense of the future. So, let's look backwards again, but this time a good bit further.

It's 1821. In England, astronomer John Herschel asks his friend Charles Babbage, an intelligent generalist, if there ever was one (a mathematician, philosopher, inventor and mechanical engineer) to double-check some manually-calculated tables of figures for him. Babbage, frustrated by finding error after error, muses: "I wish to God these calculations had been executed by steam". A humorous nod to the centrality of the industrial revolution in the popular imagination of the time – the mechanical muscle of things such as locomotives, steamboats and pieces of giant new factory equipment.

A decade later, Babbage's irritation would prove the inspiration for his and mathematician Ada Lovelace's design for the first general-purpose computer, "The Analytical Engine". However, their project never came to fruition; the design specifications of their machine exceeded the engineering prowess of the day. Yet Babbage and Lovelace's notes lay out four distinct functional components: the "mill", the "store", the "reader", and the "printer". The "mill" was the calculating unit, analogous to the central processing unit (CPU) in a modern computer, and the "store" was where data was held before processing, which is precisely analogous to memory and storage in today's computers. The "reader" and "printer" represented the input and output mechanisms, respectively

or, taken together, the user interface (UI). These three components: CPU, memory, and UI, continue to be the essential elements of every computer today.

Roughly ten years later, transcendentalist American author Henry David Thoreau famously left the hustle and bustle of urban civilisation behind to go and live alone in Walden Woods in Massachusetts. His effort to slow down and move up to a level above ephemera and glimpse the enduring. As Thoreau himself described it, this was an attempt to "Read not the Times," but rather "Read the Eternities".

We can use a ladder of our own to climb above the detail and see a broader picture. Looking at the history of modern information technology in its entirety, from Babbage and Lovelace's design right up to the current developments, we suggest that there has been a surprisingly clear line of progress in three particular layers: interaction, information and computation. We would further assert that the entire future of information technology will continue to be a story of progress and these same three layers.

Yes, because the future is still coming, there will continue to be unexpected disruptive innovations. And because the future is now coming at us that much faster, there are sure to be more of these with every passing year. But a Walden-inspired long view allows us to slow things down and see the forest for the trees. Consider the table below (Table 1), which elevates the emergence of technology from a "blizzard of buzzwords" to something that directly relates to the business of the boardroom.

2. LINES OF THE TIMES: A FRAMEWORK FOR FORESIGHT

Combining different data-analysis tools allows us to shine a light on what is possible and what is probable.

2.1 LOOKING BACK: TREND LINES

As we've already established, we must study the past to understand better where we are now and, in turn, to project those trend lines forwards to forecast the future. There's an essential thing to remember about trend lines, though: there are different kinds, and they are not all created equal.

LINEAR

Linear trends are the province of traditional strategists and forecasters. The trusty equation "y = mx + b" tells us that, for some trends, we need to know only the rate of change ("m", the slope of the line) to understand confidently, and in turn project, the state of affairs at any future date. In futurism, it's tempting to over-rely on linear trend lines because they're intuitive and typically characterise phenomena that are already sizeable. For instance, the cost of housing in global terms is "high, and getting higher", which makes for attention-

≈ **Eternities**	Babbage's design	First digital computer	Mid 20th century	Late 20th century	Early 21st century	2021: Today
Time (years)	t−175	t−75	t−50	t−25	t−10	t
⇄ **Interaction**	Reader	Punched cards	Command-line	Graphical user interface (GUI)	Mobile devices	Virtual reality
≣ **Information**	Store	Arithmetic calculation	Relational databases	Descriptive analytics	Predictive analytics	Cognitive automation
▣ **Computation**	Mill	Mainframe	Minicomputer	Client server	Cloud architectures	Distributed platforms

Table 1: A taxonomy of technological change

grabbing headlines, but is not necessarily a trajectory that holds in times of economic recession or global pandemics.

EXPONENTIAL

The thing is, most complex adaptive systems, whether they are natural or human-made, aren't linear. They're curved or, more precisely, exponential. Dr Albert Allen Bartlett famously argued that our Achilles heel as a species is our inability to understand the exponential function. Indeed, if you ask a child (or, frankly, an adult) if they'd instead earn 1 million euros or 1 cent doubled daily for a month, you're likely to hear a majority of irrational answers. In simple terms, exponential trends are those that start small, sometimes imperceptibly so, but repeatedly self-reinforce to become material, and eventually, game-changers. History tells us that the forces that most profoundly shape society tend to follow an exponential trajectory, for example, compound interest, population growth, Moore's Law and climate change.

CYCLICAL

From a too-close vantage point, every trend line looks as if it is following either a linear or an exponential trajectory. Pull the lens back, however, and some show themselves to ebb and flow over time. Consider petrol, which fluctuates due to cyclical demand and sporadic breakthroughs in the development of exploration, extraction, and refinement. Here, life experience and an appreciation for history come in particularly handy, allowing the seasoned observer to say, "I've seen this movie before."

Taken together, we can use these three types of a pattern (linear, exponential or cyclical) to broadly

FIGURE 1: Trend lines

characterise virtually any natural, social or technological trend, as illustrated in Figure 1.

2.2 LOOKING FORWARD: PROJECTIONS

Armed with an understanding of the different types of trend lines, we're now in a better position to project forward, proposing possible futures based on the aggregation and extrapolation of the data at hand.

The word projection seems particularly relevant here, as it connotes three critical characteristics of a "futures" exercise.

Firstly: like a beam projected from a flashlight, the range of potential futures is narrower closer to the present and broader further away – so the further forward we move in time, the wider the aperture of feasible futures.

Secondly: the light gets dimmer the further out you go; this is, of course, intuitive, but it is worth noting that it's easier to "illuminate" scenarios 12 months out than 12 years out.

Thirdly: we can't characterise the sides of the projected beam as a stark, binary switch from bright light to black. Instead, there are shades
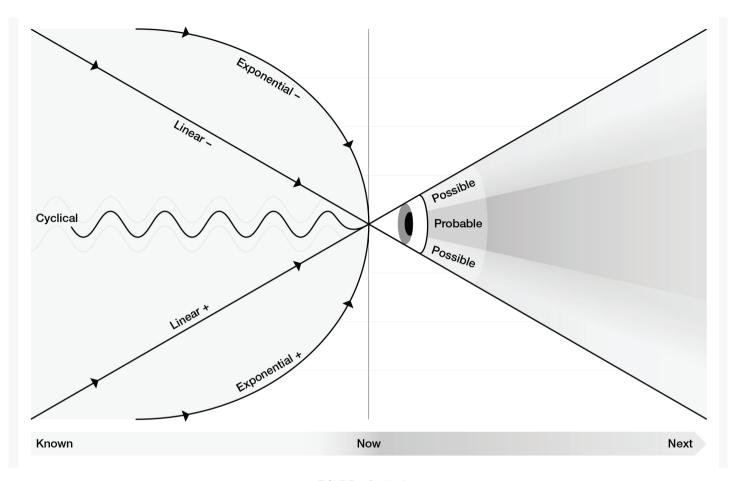
FIGURE 2: Projections

of grey that drop off in probability towards the boundaries. Respected futurists have all manner of "p-words" for the gradations here ("preferable", "plannable", "probable", "plausible", "possible", "potential"... even "preposterous"!) but for our purposes, the use of simply "probable" and (to denote "less probable") "possible" will suffice.

2.3 MAKING IT MEANINGFUL: FILTERS

As the data sources available to us exponentially increase, and the number of trend lines we can project forward also grow as a result, we find ourselves facing a problem: single "general relativity" models that can account for all historical data and all future projections become an impossibility. Consider the diagram in Figure 3.

In 1971, American economist Herbert Simon argued that as information approaches infinity, our ability to attend to it meaningfully approaches zero. Or, in other words: nobody likes an eye chart.

As a means of tackling this problem, we take a page from the realm of innovation management. We apply a domain-specific filter to serve as a liberating constraint, reducing noise, improving the signal-to-noise ratio, and resulting in a projection space that is both more understandable and, more importantly, more useful. Rather than attempt to see the entire future, we can apply, for example, an education filter that enables us to focus our attention solely on the subset of trends and projections most relevant to education (see Figure 4).

Taken together, these three analysis tools – trend lines, projections and filters – come together to create what we call a "Longitudinal Emergence Scatterplot" (LEnS). As we will see throughout the remainder of this article, it provides stakeholders with a clear and compelling rubric for thinking about where domain-specific futures are headed.

There is no one right LEnS for any given foresight exercise. Just as different business models, industries and cultures create richness and resilience, multiple LEnSes can help move us beyond a homogeneous viewpoint and towards a more holistic understanding of what may lie ahead.

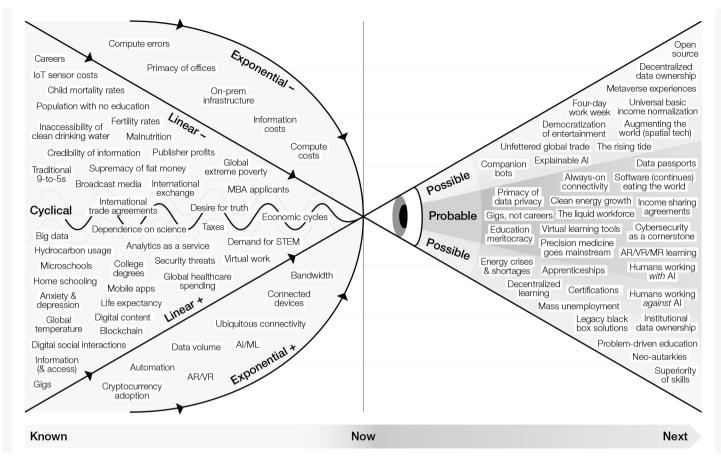For this article, we've created four broadly applicable LEnSes that, taken
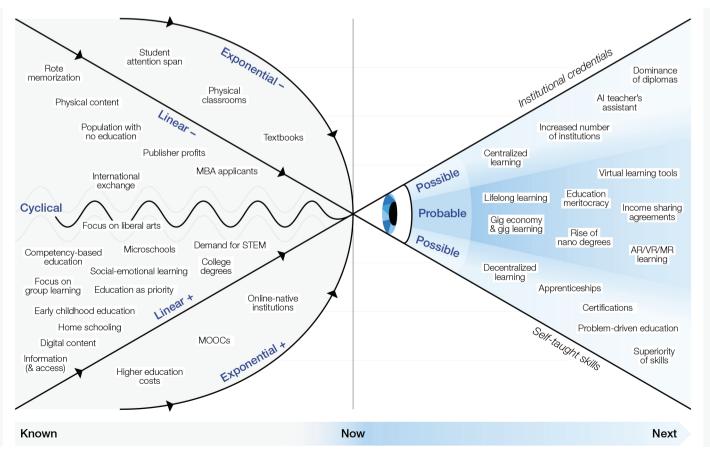
FIGURE 3: Too much information

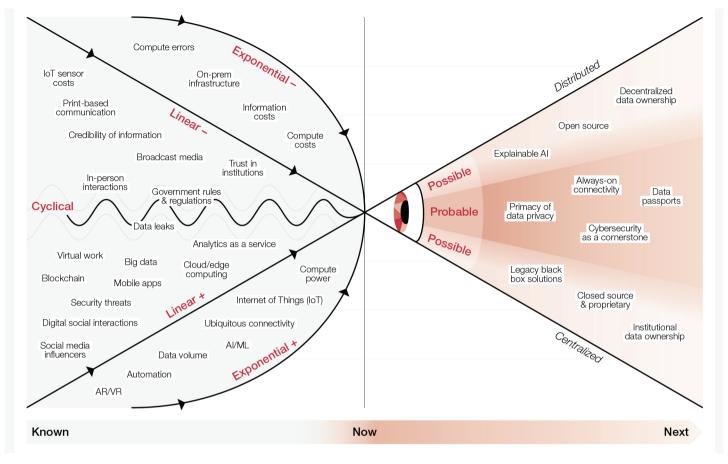Figure 4: Education LEnS (Longitudinal Emergence Scatterplot)

FIGURE 5: Information LEnS

together, demonstrate the breadth of applicability inherent in the framework: information, locality, economy and education.

It is not this article's intention to establish a mutually exclusive, collectively exhaustive (a "MECE") series of domains but rather to illustrate how individual filters provide focus, multiple filters and depth.

The following four points each begin with an introduction to one of our four LEnSes and explain the organising principles we've used in establishing and examining our trend lines.

We then project and detail a few relatively non-controversial probabilities, along with a handful of oppositional possibilities.

3. THE FUTURE THROUGH THE LENS OF INFORMATION

Data is the engine of our digital world, but where do innovations in storage, transfer and logistics look set to drive us?

3.1 CONTEXT

Data lies at the heart of the progress of information technology. In classical computing, data is a series of bits (binary digits, with a value of either 1 or 0) that a central processing unit (CPU) turns into newer and more helpful information.

Today, with help from next-generation networks that reduce latency (the time it takes for data to travel from one point to another) and cloud computing that expands processing and storage capabilities, data drives just about everything.

Data volumes are exploding. And it is not only the rate of data generated per individual increasing but also the rate at which we share information. Yet increasingly, many wonder how, and to what extent, their personal data is being shared. And who it is being shared with, and to what end?

Today, lawmakers, organisations, ethicists and many others worldwide are trying to envision data's future. Will information remain centralised, as it primarily is today? Or will we shift toward a distributed and open model of data distribution and sharing?

3.2 THE PROBABLE
ALWAYS-ON CONNECTIVITY
Gone are the days of laborious dial-up connections. Now, communicating and interacting online can involve actions as simple as tapping the finger or a

voice command, leading to substantial increases in data generation. For organisations, there is a steady increase in reliance on analytics that uses enabling technologies such as sensors, the Internet of Things (IoT: the internet-enabled network of physical objects that can connect to and exchange data with other devices and systems), robotics and ambient computing – all of which rely on the vast amounts of data that stem from our many digital interactions.

As of 2020, 2.5 quintillion bytes of data were produced every day worldwide, and it is estimated that by 2025, the generation of data per day will have reached 463 exabytes (a nearly 200x increase).

Human interaction is becoming increasingly digital, in part due to the rise of social media. In just one year, from 2019 to 2020, the number of people using social media worldwide increased by 10% to 3.96 billion, with more than two-thirds of all internet users now active on social media.

The enabling technologies that contribute to the growth of online interaction are also taking centre stage, including artificial intelligence (AI), machine learning (ML), ubiquitous connectivity powered by next-generation wireless technologies such as 5G and IoT devices.

Coupled with the decreasing costs for information and computation, these enabling technologies are gaining more traction across various industries.

We believe that as we advance, the gap between the physical and the digital narrows, the data volume of always-on connectivity will continue to grow steadily.

THE IMPORTANCE OF DATA PRIVACY

At the internet's inception, it was hard to imagine the extent to which our lives would be intertwined with digital technologies. Perhaps, for this reason, the World Wide Web was not originally designed with security or trust in mind. Today, though, increasing numbers of users are focused on how much of their personal information is shared online.

Data privacy informs how data is collected, stored, managed and shared. To address growing consumer concerns, governments and institutions in many countries worldwide are enacting rules and regulations to protect consumer privacy better. Individuals aim to take data ownership into their own hands through decentralised systems based on distributed ledger technology (which records data in multiple locations without centralised administration).

While it is too soon to understand the longer-term implications of the approaches to data privacy that organisations are now developing, a sense of urgency surrounding information security and trust looks set to remain part of the bigger picture for the foreseeable future.

CYBERSECURITY AS A CORNERSTONE

As digitisation increases steadily across the globe, there are significant security concerns about the possibility of cyber-attacks. Not only are these attacks growing in number, but given our growing dependence on information technology, their impacts are increasingly calamitous. The total number of malware infections has risen over 600% since 2009, and in 2020 the number of records

exposed through data leaks reached a staggering 36 billion. Unsurprisingly, companies and individuals are taking more extraordinary precautions to protect their data as a result.

With new technologies shaping how data is collected, shared and stored, the landscape of cybersecurity will continue to change as new threats emerge. For example, how will organisations react to cyber threats when today's public-key encryption algorithms (keys to discoverable and decryptable algorithms) are no longer secure? With its tremendous power, quantum computing (which leverages quantum mechanics to enhance computational capacity) could eventually undermine even the most advanced encryption models. With this possibility in mind, to prepare for what is coming down the road, some forward-thinking organisations are already developing quantum cryptography mitigations (technology to avoid keys being decrypted or hacked at a rapid and exponential rate).

3.3 THE POSSIBLE
DATA OWNERSHIP

INSTITUTIONAL
Across the globe, what were formerly rather vague responsibilities relating to data ownership are now being formalised into laws, rules and regulations. In 2018, the EU implemented the General Data Protection Regulation (GDPR) to regulate the protection and privacy of data. That same year in the United States, California passed the California Consumer Privacy Act (CCPA), giving consumers more control over the personal information that businesses collect about them. In addition, public officials in Europe and Asia have begun to call for the principles of data

ownership to be developed beyond the scope of existing privacy laws.

These rules on data privacy and protection may prove especially helpful with the steady growth in the use of national Electronic Health Record (EHR) systems, which have seen a 46% increase in international adoption rates in the past five years. While there is little regulation today that is specific to international data sharing for private health apps, centralised health data and data sharing solutions have proven particularly essential with the onset of COVID-19. Companies are partnering with large hospital systems to analyse patient data as part of improving care.

VS

DECENTRALISED
Today, the centralised institutions that collect personal data also actually own most of it. Due to the various privacy and ethical concerns surrounding third-party ownership of personal information, many users have taken a newfound interest in decentralised models.

Grounded in blockchain technology, decentralised data ownership provides an immutable and verifiable database that allows end-users to have complete control over who accesses their data. Several blockchain projects are currently underway to increase transparency and end-user data ownership by creating decentralised social media and web models.

Decentralised ledger technology (the basis of a transaction digital recording system in which detail is recorded in multiple locations without centralised administration) is still in its infancy. It will need to overcome technological and security obstacles before broad

adoption is possible. Nevertheless, we see decentralised technologies and approaches to data ownership playing a growing role in the future as consumers become more concerned about their personal data rights.

APPROACH TO TECHNOLOGICAL ADVANCEMENTS

CLOSED AND PROPRIETARY
As our world increasingly relies on data to drive computing algorithms and software programs, understanding how to take a strategically practical approach to related technological advancements is paramount to understanding the future of information. From a software perspective - a closed source approach keeps source code encrypted and inaccessible to the end-user. This is the primary approach for many popular apps, games and programs. Likewise, many tech companies also use this approach to safeguard proprietary intellectual property.

As the amount of data collected, stored and managed grows, business and technology leaders recognise that many legacy data management systems cannot support their organisations' AI/ML agendas. As such, they are deploying new technologies and approaches to capture, analyse and store data. In doing so, they are building the future-ready foundation that cognitive machines will need to make real-time decisions at scale.

When it comes to AI, many current models rely on closed source scenarios in which humans cannot easily interpret how the machine is making decisions. These "black box" models stem from low-stakes AI/ML decision-making (e.g. targeted advertising, which builds a picture of consumers' likes, personal information

and previous interactions to determine which products to share). But as use cases for AI/ML applications grow, so do AI ethics and bias concerns. Even the programs' designers cannot discern how their models come to certain conclusions in some situations.

With growing public awareness of and discussions around data privacy and ownership, the future of closed and proprietary approaches to software and emerging technologies could be hampered.

VS

OPEN AND EXPLAINABLE
In an open-sourced world, programs and algorithms are publicly available and adjustable by the end-user. This model provides enhanced flexibility and lower associated costs for the consumer but can sometimes lack the end-user technical support with most closed source programs.

Open source approaches offer developers more significant collaborative opportunities. They are gaining traction via the likes of Google (whose Android OS is based on Linux, an open-source operating system), IBM (which acquired open-source company Red Hat in 2019) and Microsoft (which acquired the open-source code repository GitHub in 2018).

Recent shifts to open source models indicate the increasingly collaborative nature of technology advancements and increased consumer interest in understanding how the technologies we use both works and impact our lives. However, there are still limiting challenges, such as funding for smaller platforms and security vulnerabilities. These open-source concepts are

also permeating the world of AI. In 2015, Google shifted its AI engine, TensorFlow, to an open-source model, allowing users to access their suite of AI/ML search engine models. Explainable AI, the more ethical sibling of black box AI models, provides developers with a window into how their AI models make predictions.

While these models may not eliminate closed-source and black-box approaches, open and explainable models will likely continue rising as regulatory efforts and conversations gear toward a more collaborative, open and ethical mindset.

4. THE FUTURE THROUGH THE LENS OF LOCALITY

As digital connectivity accelerates, the relationship between physical space and everyday activity is becoming far more fluid.

4.1 CONTEXT

According to British philosopher Alan Watts, "the real secret of life is to be completely engaged with what you are doing in the here and now." Over the years, the idea of "here and now" has evolved from mere physical spaces to include virtual ones as well. It is now possible to define locality in terms of physical spaces and the virtual ones in which individuals live, work, learn, and connect.

Innovation and the ongoing COVID-19 pandemic have accelerated shifts in how human beings experience locality. For example, before the global pandemic, only 17% of US employees worked from home; currently, 44% of people are doing so. Just 7.9% of the global workforce worked from home before the pandemic. However, research suggests that roughly 18% of workers have occupations

and the technical infrastructure that would allow them to do so. Against this backdrop, we see two potential extremes in the future of locality. Illustrated in the graph below, the first – a virtual extreme – represents an ongoing technological shift favouring digital and virtual interaction over the physical; the second – a physical extreme – places value on physical experiences and an underlying social discomfort with entirely virtual experiences.

4.2 THE PROBABLE
HIRING ANYONE FROM ANYWHERE

The COVID-19 pandemic has been a "trial by fire" moment for the long-entertained but seldom-tested concept of the virtual workplace. Interestingly, after a year of lockdowns and social distancing, 83% of employers in the US now say the shift to remote

FIGURE 6: Locality LEnS

work has been a success and plan to implement flexible workplace policies in the future. C-suite executives and employees alike are more enthusiastic about remote work than ever before. Virtual corporations that would only meet in person for bi-monthly "happy hours" were once considered a pipedream. Now, for some companies, this model may well become a standard operational option.

These very recent shifts in cultural acceptance are occurring in a primed world to capitalise on increased vocational flexibility. There is already a massive global talent market for employers to leverage. According to the 2020 World Investment Report from the United Nations Conference on Trade and Development (UNCTAD), employment in foreign affiliates increased 3% last year.66 Students are flocking to study abroad and to international online programmes in droves. In the face of unprecedented demand for future skills, we expect that organisations will increasingly tap into this global talent pool.

Smarter cities with healthier humans In 2020, there was a spike in the rate of American urbanites abandoning cities for the suburbs. Pandemic-induced concerns over biosecurity make the likes of crowded metro systems considerably less appealing and suburbs considerably more so. However, another catalyst for this radical change is that only 13% of the world's cities have affordable housing. People are looking to the suburbs (and beyond) for space, affordability, health and prosperity.

Advocates of urban living argue that no suburb will ever compete with the productivity, efficiency, and cultural richness to be found in cities. This

view has merit, even though both millennials (the generation defined as aged 25–40) and members of Generation Z (aged 6 to 24) are, according to recent research, now more likely to communicate with each other digitally than in person.

The future of commuting will likely include driverless taxis that ferry professionals across cities on traffic-free roads at fast, synchronised speeds. Though the increase in global urbanisation is expected to continue well into the future, we also foresee the growth of global suburbanisation. Large urban metropolitan areas may continue to spread, spurring innovation in transit, energy, services and infrastructure that exist beyond traditional borders.

VIRTUAL EXPERIENCES WITH MATERIAL INFLUENCE
Amazon Prime added 14 million new members in 2020 alone, increasing 12.5% from the previous year. In the same year, e-commerce in Canada and the US had an impressive 129% year-on-year growth, and global digital streaming subscriptions grew by over 217 million members, a 28.3% surge. To state the obvious, both shopping and video experiences that were once anchored in brick and mortar (at Blockbuster or your local supermarket) have now been replaced by frictionless, virtual counterparts.

The experiential economy is now in full swing, with 76% of consumers preferring to spend money on experiences (e.g. music concerts, live sports and travel) rather than material possessions. After the COVID-19 pandemic, it will likely take some time for communities to return to being entirely comfortable with in-person events. One study found that 66%

of people won't return to in-person events without having a vaccine. And even before the pandemic, eSports' parabolic investment growth of $4.5 billion in 2018 indicated that many niche virtual experiences and communities look set to increasingly replace in-person gatherings.

4.3 THE POSSIBLE
THE VIRTUAL REVOLUTION
MORE IS MORE: THE METAVERSE.
Since the COVID-19 pandemic, engagement with social media has increased 61% across 30 global markets. Meanwhile, digital identities are rising worldwide, and virtual relationships (romantic or otherwise) are fast becoming a necessity. Growing numbers of people are moving their entertainment, friendships, and romantic courtships to digital and virtual worlds.

Couple these cultural shifts with the rapid advancement of digital reality technologies and the projected growth in augmented reality (AR) and virtual reality (VR) markets to $1,274 billion in 2030 (a robust 42.9% compound annual growth rate). We have a compelling case for a replacement of the physical world with a virtual one. Similar to the setting of the sci-fi movie Ready Player One, a VR-enabled Metaverse (a "virtual world" enabling millions of people to share 3D digital experiences) could present unique and complex experiences in all facets of life: business, education and entertainment.

Today, we have eye-opening disruptions such as Google Expedition VR,89 UCLA Neuroscience and VR treatments for PTSD. Tomorrow, we may see an even more dynamic and enhanced world through VR and AR Metaverses.

VS

<u>LESS IS MORE: STOIC SIMPLICITY.</u>
Many of our virtual and digital connectors – social media, online gaming, video conferencing – have surged in popularity since the beginning of the COVID-19 pandemic. Although these tools are designed to connect us, they don't seem to be working the way we expected. One study found that 34% of millennials were "always or often" lonelier due to the quarantines and social distancing demanded by emergency public health policy. Despite having access to great virtual tools, many people feel that social distancing has proven that digitally-enabled reality is a poor substitute for in-person socialisation.

Additionally, a recent study of social media users found that over 24.4% of individuals had, at some point, deleted their social accounts. Many people choose a "digital detox" over connecting online with friends with renewed concerns over mental health. Some studies even describe social media as "more addictive than cigarettes and alcohol".

To complicate matters, the risk of cyber-attacks and leaks of personal data seems to be on the increase. In a world with more data gathering and more available information online to keep us dependent, people may flee from networked services to intentionally simplify.

THE PHYSICAL RESURGENCE
<u>THE SPATIAL WEB</u>
Internet of Things (IoT) devices are cheaper and more capable now than ever before and more powerful, too, thanks to near-instant 5G connections. During the third quarter of 2019, the number of 5G connections globally grew 329%, to over 17.7 million. When paired with AI algorithms, robotics and big data systems, IoT devices have the potential to analyse, predict, recommend and overlay answers to almost every day-to-day challenge presented in both our personal and business lives. At its simplest, a driverless taxi could set your desired music, window tint and AC temperature the moment you hop in the car.

At its best, the AR cloud has the potency to launch a near-term revolution in the spatial web by mapping everything we do in the real world to digital information and enhancements. As one study puts it, the spatial web would "fully erase the line between digital and physical objects". Surgeons would, for example, perform diagnostics and surgery from another part of the world thanks to advanced haptics (technology that creates an experience of touch), precision robotics and enhanced 3D digital modelling, or students would learn about blood cells by exploring the human bloodstream virtually. The possibilities are endless.

VS

<u>REALITY REDUX</u>
In the past decade, spending in the US on live experiences and events (relative to total spending) has substantially increased. Some reports released just before the beginning of the COVID-19 pandemic projected that the global live music market would accelerate at a 9% compound annual growth rate into 2024, signalling an increased consumer preference for "being somewhere" instead of "beaming anywhere".

Studies have demonstrated the importance of physical presence in looking at the quality of our interactions with the surrounding environment. It has been shown that proper exposure to sunlight and meaningful interaction with nature creates happier, healthier and more fulfilling lives. Interacting with other humans and creating meaningful relationships also contributes positively to our health.

It's not our projection that most people will entirely forego virtual tools – be it a convenient smartphone, an "always-on" spatial web that relays constant information to us, or an AI that predicts our every need. Instead, we anticipate that, as virtual alternatives become more available, more people will struggle in determining when to choose reality.

5. THE FUTURE THROUGH THE LENS OF THE ECONOMY
In the face of finite physical resources, the world needs well-informed strategic responses to avoid an unsustainable future.

5.1 CONTEXT
The economy LEnS considers finite raw materials and their development into higher-order economic outputs. Resources (energy, infrastructure, clean water, etc.) are necessary for humans to survive and thrive. "Economy" covers the value-added creations developed from those materials (jobs, trade, production, etc.).

In a world where technological change constantly disrupts the availability and usefulness of resources, how we embrace technological innovations can often matter more than the technologies themselves. Will our collective future be characterised by abundance, with resource availability and economic growth rising along
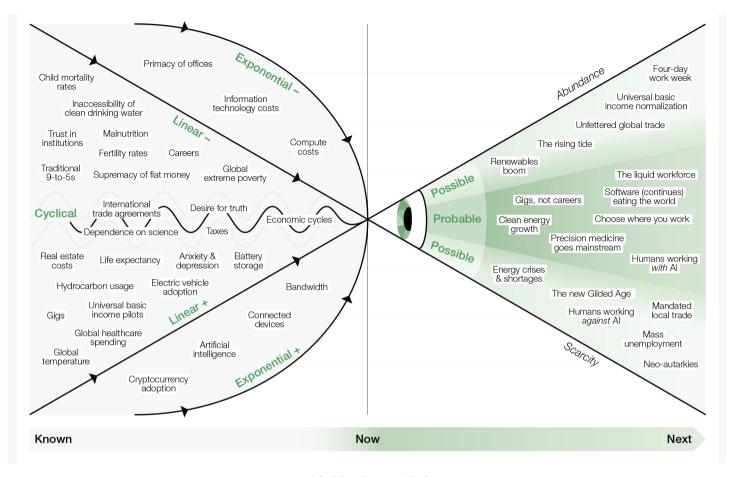
FIGURE 7: Economy LEnS

with the tide of increasing global technological prowess? Or, will we find ourselves in a world of scarcity, where global inequality and tribalism result from a shortage of access to resources? See Figure 7.

5.2 THE PROBABLE
Software (continues) to eat the world
The exponential rise of artificial intelligence usage, bandwidth capacity, and spend on IT and computing signal that software advancements will continue to drive and enable global economic output. As the costs of IT and computer purchasing continue to fall (i.e. we can purchase more with less), we expect to see more grassroots innovation in this sector and more adoption across different industries.

THE LIQUID WORKFORCE
The rise of the "gig worker" is helping shift the established pattern for work from the traditional "9 to 5" to "whenever suits my preference".

This rapid move towards flexibility affects the gig-work sector and traditional companies, as they must now manage employees' increasing demands for work styles that allow for personal plasticity. More people reject the once-dominant principle of "one career, one company", favouring the concept of a "liquid workforce" that supports their changing needs. Add to this dynamic two more factors: the increase in pilots for a universal basic income and a continuous increase in the elderly as a proportion of the population. Both trends signal

reconfigurations of how we work and societal expectations about why we work and for how long.

CLEAN ENERGY GROWTH
It is an understatement to say that our energy needs are increasing. Fossil fuel consumption has risen by 9% globally over the past decade, with roughly 84% of primary energy coming from coal, oil and gas in 2019. Against a backdrop of exponential growth in connected devices and rapid industrialisation, our current energy supply will be limited in its ability to support future demand.

Currently, renewable and low-carbon energy sources show increasing commercial viability and consumer adoption. Moreover, advances in

battery technology, such as solid-state electric vehicle (EV) batteries, are paving the way for an EV-led future. Although non-automobile EV adoption is expected to lag behind automobiles, we anticipate that alternative sources of clean energy will further fuel a gradual shift into increasingly "clean" transportation. Although traditional oil and gas sectors will continue to comprise a large portion of our energy supply for the foreseeable future, clean energy adoption will probably continue to increase over time.

5.3 THE POSSIBLE
SUSTAINABILITY
BOTH KINDS OF "GREEN."
Advancements in renewable energy sources, alongside broader societal trends such as falling birth rates, will lend a significant hand in the fight against climate change.

Although devastating in many different ways, the COVID-19 pandemic has also brought a temporary decline in CO2 emissions, with a nearly 17% decline by early April 2020 as compared to 2019 levels. International travel alone declined by 70% from January to August in 2020. The duration of this contraction is expected to remain closely related to the severity of the pandemic.

How we choose to embrace sustainable practices in a post-COVID world will be pivotal in our fight against climate change. We may return to travel-intense, commuter lifestyles that help fuel climate change.

However, it is also possible that we will refuse to return to our pre-pandemic version of "normal" instead of forging a new sustainable path forwards for our world that does not sacrifice corporate profitability.

Many companies have already created policies that promise to help move towards a new "normal". San Francisco's largest private employer, business software company Salesforce, announced in February this year that after COVID-19 restrictions are lifted, it will let most of its employees work from home two days a week. The extent to which more companies and governments follow suit will be a significant determining factor in our collective fight against climate change.

VS

A RETURN TO "NORMAL."
Rising fossil fuel consumption and deforestation have led to a rise in global temperatures, at a rate of roughly 0.18°C per decade since 1981. Although an imperceptible rise of 0.18°C per decade might seem marginal, even almost irrelevant, to us as human beings, it already impacts the world's ecological systems.

A return to "normal" in a post-pandemic world would further accelerate the undesirable march towards a rise in global temperatures. Although nearly half (48%) of US employees currently working at home for their employer have said they would like to continue working remotely after the COVID-19 crisis is over, that also means that just over half would like to continue commuting to physical office spaces for work.

Travel to and from work is also just one part of the complex picture on emissions. In 2016, emissions from transport made up only 16.2% of global greenhouse gas emissions. To make significant headway on fighting climate change, emissions will have to be cut across other categories

such as "industry" and "energy use in buildings", which account for 24.2% and 17.5% of greenhouse gas emissions.

To paint a rosy picture for a future grounded in sustainability is to ignore reality. Advancements in clean energy show promise, but technological advancements without proper adoption will likely leave us no better off than when we started.

ECONOMIC OPPORTUNITY
THE NEW GILDED AGE
In the 19th century, the US experienced a period of unprecedented economic expansion, which produced huge profits and increased income inequality and class conflict. Dubbed the "Gilded Age", this era shows some flavour of the world today.

Globally, although extreme poverty has consistently fallen for decades, it is expected to have risen again in 2020. This is because the COVID-19 pandemic has disrupted the effectiveness of efforts to continually reduce the causes of extreme poverty, even if the overall rate has continued to decline. It is uncertain whether extreme poverty (especially in locations such as South Asia and Sub-Saharan Africa, regions that together are home to nearly 85% of the world's poorest people) will continue to decline (albeit slowly) or if a cyclical pattern will be established, with rises and falls pegged to the current state of global affairs.

Extreme poverty is one measure for evaluating economic prosperity; the concentration of capital is another. Just as extreme poverty is regionally distributed, so too are the levels of capital concentration in different countries. Although it would be an

oversimplification to suggest income inequality is on the rise everywhere, some of the world's most populous countries (the US, China, India and Indonesia) have seen a rise in income inequality over the last 25 years.

Pair this with falling trust in institutions, rising real estate costs, mass unemployment due to the pandemic, and declarations of similarities with the "new Gilded Age" no longer appear tenuous.

VS

A RISING TIDE
Over the last few decades, technological innovations have driven improvements in clean water supplies, access to proper nutrients, and the quality of healthcare.

In 2000, over 38% of the global population did not have access to clean drinking water. Just 15 years later, that percentage had dropped to 29%. Although there is much progress to be made, especially in regions such as Sub-Saharan Africa, a more significant share of our global population is expected to have access to clean drinking water over time.

In looking at the regional daily supply of food calories from 1993 to 2013, all global regions have continued increasing their food available for consumption, with increases most significant in Africa and Asia.

As for healthcare, decreasing fertility rates, decreasing child mortality rates, and increasing life expectancy indicate real progress is being made on improving global health. Although healthcare spending continues to expand faster than the economy
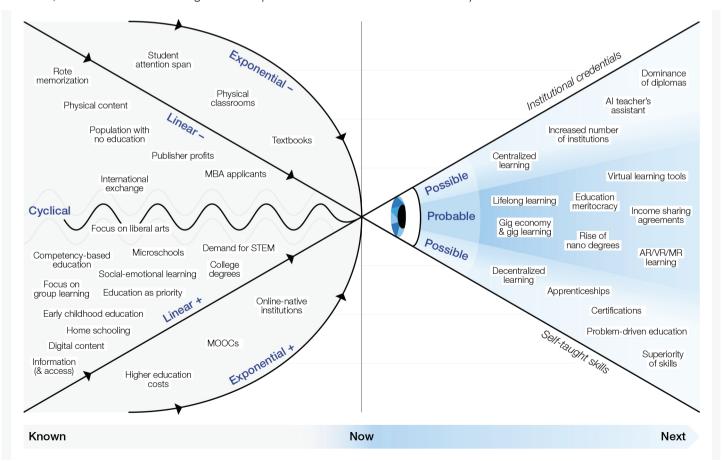
(between 2000 and 2017, global health spending in real terms grew by 3.9% a year, while the world's economy grew 3.0% a year), breakthrough advancements in gene sequencing, 3D-printed organs, and artificial intelligence applications in life sciences indicate a future of "more bang for your buck" on healthcare spending.

6. THE FUTURE THROUGH THE LENS OF EDUCATION
Educational norms relating to where and how people learn, and at what point in their career, are rapidly being dissolved

6.1 CONTEXT
Famously dubbed "our passport to the future" by Malcolm X, education can be broadly defined as how individuals learn and teach them the skills they need to build successful careers.

FIGURE 8: Education LEnS

Every day, in countries worldwide, people consciously decide to learn something new, using formats and programmes such as digital and physical resources, skills-based training and self-paced training to absorb information. Advanced modes of accessing information are driving dramatic shifts in the ways people learn and institutions teach, a trend that is likely to lead to the development of two future educational norms.

In the first, which we describe as "institutional credentials", the kind of structured education traditionally offered by school systems and universities will remain in place, but with new tools and teaching methods.

In the second, more disruptive scenario, traditional education with its emphasis on formal accreditations will give way to a more meritocratic system of "self-taught skills" that prizes demonstrable competency, real-life problem- solving and the creation of measurable value.

Despite all the unknowns, several trend lines that have been established over the last decade help bring into sight futures that, although uncertain, are still substantially plausible.

6.2 THE PROBABLE
PERSONALISING EDUCATION
If the "gig working" economy continues to increase in the future, so will the "gig learning" economy. The pace of technological change in the workplace is unlikely to slow, with current projections making assertions such as "65% of children entering primary school today will ultimately end up working in completely new job types that don't yet exist." Thus, in tomorrow's careers, lifelong learning will become a necessary means of staying relevant.

Over time, enough people investing in lifelong learning might naturally encourage decoupling degree and diploma programmes. This decoupling could support the expansion of "nano degrees" (a "project and skills-based educational credential" delivered entirely online, which is far quicker to obtain than a conventional degree) into areas of study beyond computer science, allowing individuals to more easily keep pace with a rapidly changing skills landscape. Although the number of conventional learning institutions continues to rise, the cost of the tuition they provide is also increasing to match. These rising prices could make institutional education unattainable for future generations, forcing students to re-evaluate the value of formal accreditation. Instead of students asking themselves, "What do I want to be when I grow up?" they might very well ask instead, "Which job looks interesting as a starting point?" So if the answer to the first question was, "I want to be a doctor and go to medical school for seven years", it could equally be, "I'm interested in science and want to explore a short course on biology". Acting on those intents leads to a very different skillset and requires a different upfront investment.

DIGITISED AND VIRTUALISED CONTENT
The demand for physical classrooms and physical textbooks is falling exponentially, and as an inverse mirror to these twin trends, the market for digital classrooms is growing exponentially. One illustration of this is the 10% year-on-year growth of massive open online courses (MOOCs). Digitising and virtualising education is certainly economically efficient, but there are a few other potent incentives in this transformation.

Today our access to information worldwide is unparalleled in scale to any other period in human history. In addition, there is specific evidence that globally, attention spans - especially in young learners - have decreased dramatically. These trends create rich soil for innovations in two critical attention-holding learning technologies: digital classrooms and AR/VR learning experiences.

For example, one European business school now has a "100% digital campus", and companies such as Google Expeditions VR, VR Education and are pioneering the future of a range of zSpace AR different AR and VR learning experiences.

6.3 THE POSSIBLE
THE VIRTUAL REVOLUTION
PROVEN COMPETENCY
For millennia, students have looked to too expensive, formal institutions to access knowledge and train their desired profession. Recently, however, Harvard Business Review identified a severe "skills gap" caused by the inability of formal education to keep pace with technological advancement.

As employers are increasingly confronted with the need for people with rare skills, they may become more comfortable with non-traditional, decentralised sources of knowledge, with candidates proving aptitude through real-world projects and problem-solving. Google, Apple, and Netflix are a collection of the most successful tech companies globally, yet they do not require employees to have tertiary education. "Gig work" further disrupts the traditional recruitment rules by enabling a company to hire a single employee with specialised skills instead of a team of well-rounded, institutionally-trained generalists.

Aside from a recent rise in applications primarily attributed to the uncertainty caused by the arrival of COVID-19, the number of MBA applications is overall following a downward trend in the US. Demand for competency-based education is increasing steadily and perhaps will replace formalised college degree programmes. If these trends continue – both the relaxation of corporate requirements and a decrease in demand for institutional education – we believe the future of work could be increasingly characterised by more meritocratic, skill-based hiring and a focus on apprenticeships and other forms of on-the-job training.

VS

TERTIARY DEGREES
Traditional institutions offer something that no informal education can: respect due to the institution's historical reputation and a de facto "seal of approval" for any student who graduates with honours. The University of Oxford, founded nearly 1,000 years ago, is as influential now as it ever has been, with an endowment of over £6.1 billion and an annual budget of £2.14 billion. Finances aren't the only aspect of traditional education that is flourishing, however. By 2030, the number of young people completing a tertiary degree across OECD and G20 countries is expected to increase to 300 million, up from 137 million in 2013. To accommodate this demand, it's reasonable to expect a continued increase in institutional capacity, as well as the number of traditional institutions.

As digital learning disrupts long-established pedagogies, respected institutional brands may increase their capacity and expand their enrollment in a wide variety of online courses. It is reasonable to expect that bolstered global interest in virtual attendance at the world's leading universities and technologies, including AI, will help traditional institutions personalise learning and maintain their stellar track record as they scale to a broader audience.

Institutions have survived and thrived through centuries of advancements in locomotion, electricity and computation. Therefore, it is reasonable to expect this resilience will continue in the face of current shifts in demand. Those institutions will readily adapt to the rapidly growing international market for education.

FINANCING THE FUTURE
ALTERNATIVE FINANCING
The meteoric rise in tuition costs and increasing demand for specific skillsets means that the development of alternative financing in higher education appears likely. The cost of tuition is rising globally "eight times faster than wages", a fact that has the potential to dissuade many talented, potential students from even considering higher education.

The good news is that in the internet age, since the early 1990s, the percentage of the global population that has had no formal education has dropped dramatically – nearly every country has seen a 50 to 100% decrease. The bad news: there is still a lot of unmet demand for science, technology, engineering and maths (STEM) skills, and other future fields as yet unknown.

In response, alternative forms of tuition financing will increasingly be available to support students in investing in courses that gain them highly sought-after skills. Income-sharing agreements (ISAs) – financial agreements in which students share a portion of future earnings to pay for their tuition – are one such financing option that is currently garnering interest from investors. The start-up Blair received $100 million in 2019, and, in the same year, Lambda raised $30 million in funding to double-down on their ISA programs. A rise in alternative financing options will likely empower students to pursue skills-based training while forcing institutions to offer concrete evidence of the value of their teaching skills.

VS

TRADITIONAL LOANS
The cost of tuition is rising. However, this rise is justified by the market, as there is an increased demand for courses at higher education institutions. Prices don't seem to be deterring students: in 2015, in the UK, it was found that "students' attitudes toward taking on student loan debt were more favourable in 2015 than in 2002", and that the student loan market is thriving. Consequently, universities with a global reach have more considerable average endowments than ever before.

And who should foot the bill for a student's education? Although government aid intuition forgiveness may help many students pay for tertiary degrees, this support may have the adverse effect of disincentivising an institution to be economically efficient. Though income-sharing agreements are gaining traction in niche courses that teach lucrative skillsets, students from low-income backgrounds still cannot readily use an ISA. Perhaps alternative funding sources will increase in popularity for small percentages of the student loan

market; however, most students may still wish to pay for tuition through a traditional loan offered directly by their college, government, or financial services provider.

7. READY TO SHAPE THE FUTURE

An explanation of where the probable futures we've seen are likely to converge offers clear take-homes for robust planning.

7.1 SIGNALS IN THE NOISE

The preceding five sections of this report are all characterised by divergent thinking. In section 2, we looked at technology-enabled futures that follow enduring, accelerating trajectories. The following four sections (3 to 6) fleshed out this assertion using LEnS, a novel model for foresight that projects historical trend lines through domain-specific filters. Then the story sections dove right in, complementing a research-based understanding of the future with four attempts to describe what it might feel like for the people who will inhabit it. Just thinking about

different kinds of futures is insufficient. We must also work to try to imagine and, in a sense, feel them. How is that for divergence?

However, it is now time to focus on convergence, and in doing so, empower leaders by offering them some means of preparing for these futures.

Luckily, there are signals in the noise. In section 1, we described the three "eternities" that have characterised the trajectory of information technology since Charles Babbage and Ada Lovelace designed their "Analytical Engine" in the early 19th century: interaction, information and computation. Armed with this broad-brushstroke understanding of tech's journey to the present and a LEnS-inspired extrapolation from the technologies currently emerging from universities, start-ups, and corporate R&D labs, we can see each of these three developments layers appears to be converging towards a clear and coherent endpoint. See Table 2.

7.2 "SIMPLICITY IS THE ULTIMATE SOPHISTICATION."

Though erroneously attributed to everyone, from Steve Jobs to Leonardo da Vinci, artist Leonard Thiessen's quote is still endorsed by the history of information technology, which has been a story of our building ever more natural and intuitive interfaces. Early punched-card input/output was exclusively the province of PhDs. There were graphical user interfaces (GUIs).

Command-line interfaces, only slightly less Byzantine, led to a generation of professional computer operators having to take night school classes to keep up with the pace of change. Mobile became de rigueur, and now we've got to the point where the idea of an interface requiring instructions rather than being intuitively easy to use is starting to seem anachronistic. Today's conversational interfaces (think smart speakers and phone-based digital assistants) and emerging AR/VR overlays require only that

Eternities	Babbage's design	First digital computer	Mid 20th century	Late 20th century	Early 21st century	2021: Today	Horizon next	Furthest stars	Endgames
Time (years)	t−175	t−75	t−50	t−25	t−10	t	t+10	t+n	t=∞
Interaction	Reader	Punched cards	Command-line	Graphical user interface (GUI)	Mobile devices	Virtual reality	Ambient experiences	Brain-computer interfaces	Simplicity
Information	Store	Arithmetic calculation	Relational databases	Descriptive analytics	Predictive analytics	Cognitive automation	Affective AI	General AI	Intelligence
Computation	Mill	Mainframe	Minicomputer	Client server	Cloud architectures	Distributed platforms	Spatial web	Quantum computing	Abundance

LEnS framework utilized to project t+ timeframes

TABLE 2: From eternities to endgames

you can speak your native language or physically gesture towards your intentions, respectively.

Suppose smart speakers and AR get us "beyond the glass". In that case, ambient interface technologies (a collection of autonomous devices and technologies that interact and sensitive to human needs) move us "beyond the device" entirely, creating digital awareness in the user's entire environment. The prospect of 15 separate digital assistants in every room and context is unwieldy and thus unlikely. As such, the next wave of interfaces is likely to "get out of the way entirely", becoming cloud services in much the same way that yesterday's servers and desktops did before them. In this projected scenario, "[Device], what's the weather?" gives way to a far simpler, "What's the weather?"

The idea here is that the most qualified digital entity snaps to attention with the highest-confidence answer, as brokered and sub-contracted through a network of digital assistants, moving down the line. In this digital Downton Abbey, the user need not know the names of all their staff.

And in the furthest possible future? Brain-computer interfaces. As startling as "microchips in brains" may seem from the present, when looked at through a long lens, this proposition is simply the removal of the final communicative barrier between human and machine: speech. Why bother asking, "What's the weather?" when you can simply think that question and have it answered? Or, when the sun goes down in the evening, enjoy the thermostat's doting response to the subconscious call of your parasympathetic nervous system for warmth?

7.3 MIND THE DIGITAL GAP

While underlying enabling technologies grow more complicated, their reach, accessibility and usability grow exponentially. Leaders would be wise to plan for a world where every interaction is mediated through a technological interface. In 2011, venture capitalist Marc Andreessen famously said, "Software is eating the world". His statement recognised that it is bits and bytes rather than bricks and mortar, which will define our future.

Digital experiences are more scalable than physical. Software, thanks to updates, can improve over time. Physical hardware depreciates while compiled code is protected and less prone to reverse engineering. COVID-19 has further catalysed this shift. As the pandemic stressed physical supply chains beyond their limits, digital networks proved as elastic and resilient as ever. The primacy of digital is no longer in doubt.

The governance and policy takeaways are myriad, but the increasing importance of digital, virtual and ambient experiences brings with it a risk of an exponentially widening digital divide.

Today, commercial sports stadia are being constructed that require the use of a mobile phone to enter (digital ticket), transact (digital wallet) and engage (digital scoreboard). Will tomorrow's public services be designed in such a way as to require digital ID's? AR glasses?

It may be critical to ensure that access to necessities doesn't gradually begin to require, or even presume, the availability of certain commercial technologies.

7.4 INTELLIGENCE IS AS INTELLIGENCE DOES

Cinema's consummate everyman recognised that their actions, not their appearance, should judge a person. Forrest Gump said that "Stupid is as stupid does." Our research suggests that Gump's homespun wisdom applies equally well to the future of information and machine intelligence. Indeed, a perspective informed by the long arc of history suggests that even the term "artificial intelligence" (AI) may well become an anachronism – a label belonging to a transitional time, one in which we were yet to realise that, whether it sits in vivo or silico, intelligence is intelligence.

Consider the impact of AI: as machines become more capable, feats considered to require intelligence are often stopped from helping to define what AI is. "AI" has thus become a catch-all term for whatever machines cannot do yet. Our human need to feel exceptional finds us simultaneously dismissive of past advances in machine intelligence (e.g. the computer Deep Blue beat chess champion, Gary Kasparov, in 1996, and in 2015 AlphaGo became the first computer to beat a human professional at Go without handicaps) and doubtful about upcoming milestones.

Our psychological fragility notwithstanding, AI's next act is likely to be 'affective intelligence': the ability to discern and emulate human emotions and, in turn, to begin to engage in empathic interactions and even relationships. Imagine humorous machines, charming machines, or even spiritual machines.

To the degree that humour, charm or spirituality continue to become describable by data, they, in turn,

become increasingly learnable by deep neural networks. It is probably little in the way of individual human skills – even soft and creative skills or the coherent expression of beliefs – that machines won't one day emulate given enough information and computation.

And after that? The furthest possible informational futures point toward versatility. Machines' astonishing ability to learn and subsequently master individual skills is one thing. However, the ability of a single machine to emulate a well-rounded individual's skills and personality is still a long way off. When it comes to general intelligence, the standard for "success" isn't set regarding Einstein or Shakespeare. In their earliest incarnations, digital personas will likely underwhelm. It is likely, though, that thanks to exponential increases in training data and processing power – and an increasing symbiosis between technology and human biology – we will likely see mechanical minds quickly follow an upward path towards eventual parity with, and even superiority to, our own.

The rise of machines is already well underway and accelerating. Popular science fiction tends to make this a story about malevolent sentience – mechanical minds as supervillains with dark agendas. In truth, the software has always been neutral, manifesting its developers' explicit orders and tacit biases. As information technology continues to evolve from our telling machines what to calculate towards teaching machines what to discern, it will be increasingly important for organisations, governments and regulators to closely monitor the "curriculum". How can we develop artificial intelligences that embody our explicitly shared financial, social and ethical values? We must train our digital children well, training them to do as we say, not necessarily as we've done.

7.5 DON'T BET AGAINST AN ABUNDANCE OF INGENUITY

As already described in our section on the economy LEnS, our planet has a finite supply of certain precious elements, chemical compounds and organic species that we would be wise to steward well. In contrast, human ingenuity – our shared creative capacity – is inexhaustible.

Consider the current computational shift towards trustless distributed ledger platforms, a technology based on a new trust paradigm that eliminates the need for third-party processing. This computing evolution speaks to recognising that perhaps none of us is as trustworthy as all of us. If the 20th century marked evolution from "In God, we trust" to "In man we trust", the current century would seem to be heading towards "In maths we trust" – specifically the mathematics of cryptography (protecting information through the use of codes).

In 2014, French economist Thomas Piketty's new book Capital in the 21st Century213 warned of widening inequalities in wealth and income; few foresaw then-emerging technologies such as Bitcoin (let alone Reddit) as a populist counter- punch. Together, blockchains and cryptocurrencies signal the possibility of radical disintermediation. In a world where trusted hubs give way to trustless spoke-to-spoke transactions, information and capital are freer to flow and seeking payment for it (rent-seeking behaviours) harder to justify. If the internet brought about the death of the salesman, the distributed web promises to bring about the death of the middle man.

The distributed web also stands to enable an altogether new "Web 3.0" or "spatial internet". As the lines between the physical and digital continue to blur, a new generation of internet architectures stands ready to append information to every physical person, place and thing. The idea here is that our conception of physical reality itself will be coming online. No single government, or company, could reasonably be trusted to hold all that data. Still, a trustless distributed computing network may provide just the balance of privacy and performance needed to power our AR and AI-enhanced future.

And after reality goes online? Imagine reality itself used as a computer. Quantum computing gives us the power to solve particular classes of complex problems faster and other classes of previously intractable problems for the first time. Current academic references to quantum's theoretical efficacy in chemical compound simulation tend not to stir the heart, but the possibility that those simulations could in turn yield medicines and genetic interventions that may cure cancer or even delay or defeat death altogether? Now you have our attention.

7.6 INVEST IN MOONSHOTS

Our species has always been defined (or at the very least, differentiated) by our ability to learn, create and adapt. Roughly 2.6 million years ago, homo habilis created the first stone tools, thus freeing time and energy for higher-order pursuits. The Sumerians created the first written language 5,000 years ago as a life hack for offloading knowledge. Like stone

tools, this advance also freed time and energy for other pursuits, except this time of an even-higher order.

Five hundred years ago, the printing press similarly provided a life hack for communication, and 75 years ago, the digital computer one for calculation. When seen through this long lens, projected advances in computing are neither hero nor villain. Instead, they represent the latest in our species' long series of transformative adaptations in the pursuit of efficiency.

Though the challenges we face are becoming progressively more complex, our collective creativity and intelligence appear to be evolving faster than the challenges themselves. Humanity's ability to come up with life hacks – whether made of stone or bits and bytes – seems set to continue to give us an exponential edge in raising a response both to today's threats and tomorrow's perils.

Leaders should consider allocating time, mindshare and money for moonshots – projects that might not help us compete today, but given enough inspiration and perspiration, can help us create tomorrow.

American architectural pioneer Daniel Burnham (known for his city plan for Chicago) captured the clarion call of the long view in 1891:

Make no little plans; they have no magic to stir [our] blood and probably themselves will not be realised. Make big plans; aim high in hope and work, remembering that a noble, logical diagram once recorded will never die, but long after we are gone, be a living thing, asserting itself with ever-growing insistency. Remember that our [children and grandchildren] are going to do things that would stagger us. Let your watchword be order and your beacon beauty.

Inspirational quotes are not business cases. But in the context of the long view (looking both forward and backwards), they remind us we as business, civic and academic leaders must spend time thinking beyond quarterly numbers and quarrelling constituents. Indeed, we must plant seeds in a field we will never harvest.

That's not just stewardship; that's leadership. **w**n

Quantum Communications

Possibly one of the most pressing problems confronting global communications is the ability to transmit secure information that cannot be hacked. It is here that quantum communication holds the most promise.

During WW2, the use of the ENIGMA electro-mechanical machines was thought to provide uncrackable encryption. These used a set of rotors for substituting characters, which would be advanced with every character encrypted.
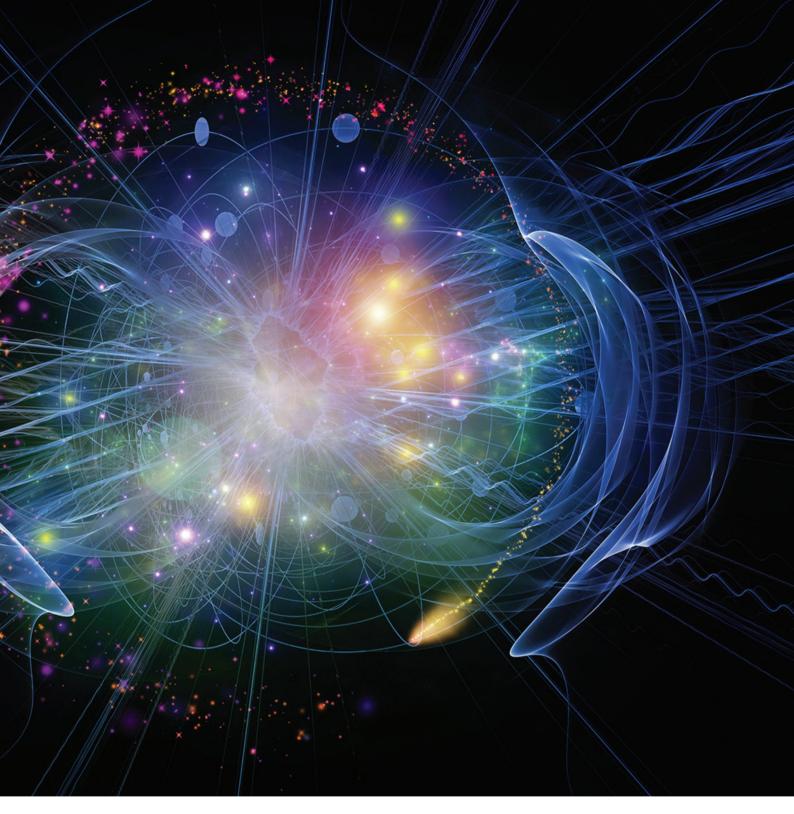
COMPILED BY I DUDLEY BASSON

The ENIGMA system failed dismally, primarily due to the work of Polish encryption specialists, computer pioneer Alan Turing and the capture of an ENIGMA machine and codebooks from destroyed enemy submarine U-559. The cracking of the ENIGMA system had a decisive influence on the duration and outcome of the war.

It has been suggested that the name ENIGMA was taken from the *Enigma Variations* of English composer Edward Elgar. In Elgar's variations, the enigmatic theme is encrypted by not playing the theme explicitly but only a counterpoint based on it. Several suggestions have been made for the identity of the original theme.

For details of the ENIGMA machine, click here.

Another notable success in encryption cracking was achieved by American cryptographers who cracked the Japanese naval codes during WW2. This was particularly significant for the battle of Midway.

Modern encryption is indeed uncrackable, even by the fastest supercomputers – the problem remains with QKD (quantum key distribution) - getting the key safely to the sender and recipient. The keys are generated individually for each transmission and are not reused.

In the Symmetric Encryption Method or private–key cryptography, both sender and receiver use the same key, making it vital that the key remains secure until the transmission has started.

Early voice encryption used pre-recorded noise which was added to the signal and then subtracted by the recipient. In modern voice encryption, the signal is digitised before encryption.

Fundamental to quantum communications is the qubit and quantum entanglement. Unlike the classical binary (0 or 1), qubits can have values of 0, 1 or a superposition

of both. Large numbers can be compactly expressed by using qubits. Quantum entanglement means that two entangled quantum particles can continue to influence each other instantly, even when separated by a great distance. Einstein did not like it, calling it *'spukhafte fernwirkung'* – spooky action at a distance. Like it or not, entanglement is here to stay and will become a fundamental part of encrypted global communications. Photon qubit quanta are used for quantum communications and transmitted by fibre optic cable or light waves and received by the telescope.

For a technical look at qubits and quantum entanglement (using Dirac's bra-ket notation), click here.

The work of Dirac and Turing has been described in the March 2017 issue of **watt**now.

In a significant scientific leap, University of Queensland researchers have created a quantum microscope that can reveal biological structures that would otherwise be impossible to see.

From UQ's Quantum Optics Lab and the ARC Centre of Excellence for Engineered Quantum Systems (EQUS), Professor Warwick Bowen said it was the first entanglement-based sensor with performance beyond the best possible existing technology.

"This breakthrough will spark all sorts of new technologies – from better navigation systems to better MRI machines; you name it.

We've finally demonstrated that sensors that use it can supersede existing, non-quantum technology.
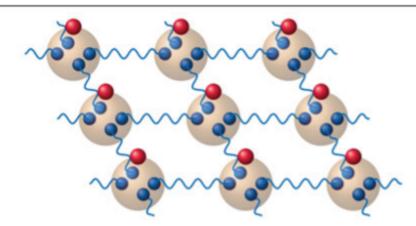
Entanglement is set to revolutionise computing, communication and sensing".

In 2005 in the journal Genome Biology, it was suggested that a magnetic sense in birds that seems to enable them to navigate during migrations might be based on quantum physical processes in flavoproteins called cryptochromes. These are involved in the circadian rhythms and the sensing of magnetic fields in several species.

What exactly are a quantum particle and a qubit? Information on this most abstruse matter can be found here.

WATCH: For an excellent lecture, "A Brief History of Quantum Mechanics" by physicist Prof Sean Carroll (56:00 mins):
See also the comments following the lecture.

Determining the properties of a quantum system of real particles (red spheres) is as Complicated as it gets, as all the particles interact among each other. The physicists in Garching therefore describe each real particle with four virtual particles (blue spheres), each of which is entangled with a virtual particle (indicated by the wavy lines). Because the virtual particles are projected onto the real particle (indicated by the large beige-coloured sphere), physicists call this 'projected entangled pair states' (peps) – one example of a tensor network.
Tensor networks can be used as algorithms to simulate an unknown quantum system by means of a known one.
Quantum computers can manage tasks that would overwhelm even today's supercomputers In practical computing time, as they can carry out massively parallel quantum calculations With the aid of the quantum physical entanglement of qubits.

A telling comment in the lecture: *"An understanding of field theory cannot be achieved by studying reality – field theory must be studied to understand reality."*

A comment from Nobel laureate physicist Richard Feynman: *"I think that I can safely say that nobody understands quantum mechanics."*

A comment from physicist Prof David Deutsch: *"Despite the unrivalled empirical success of quantum theory, the very suggestion that it may be literally true as a description of nature is still greeted with cynicism, incomprehension and even anger."*

The lifespan of entangled photons is less than a millisecond, but it is possible to store and retrieve entangled photons at room temperature using caesium vapour and lasers. The short life of entangled photons may require quantum repeaters for long-distance communications, but these cannot presently handle large amounts of traffic.

In a paper published in *Science Advances* on December 14, researchers from Austria, Sweden, and Italy demonstrated that they could make quantum repeaters more efficient by creating already-entangled photons when needed.

They did this using quantum dots, which are semiconductors that will emit specific frequencies of light when excited by electricity to create pairs of entangled photons via quantum interference. With this technique, quantum repeaters will have a ready supply of entangled photons to handle as much data as needed.

QUESS (Quantum Experiments at Space Scale) is a Chinese research project in quantum physics.

China reached a new milestone in space-based quantum communications with the nation's Micius satellite, launched on August 16 1916, successfully establishing an ultra-secure link between two ground stations separated by more than 1,000 kilometres – Karen Kwon on 25 June 2020 wrote:

"Chinese scientists have established the world's first integrated quantum communication network, combining over 700 optical fibres on the ground with two ground-to-satellite links to achieve quantum key distribution over a total distance of 4,600 kilometres for users across the country. The team, led by Jianwei Pan, Yuao Chen, Chengzhi Peng from the University of Science and Technology of China in Hefei, reported in Nature their latest advances towards the global, practical application of such a network for future communications."

Unlike conventional encryption, quantum communication is considered to be unhackable and therefore, the future of secure information transfer for banks, power grids and other sectors can be assured. The core of quantum communication is quantum key distribution (QKD), which uses the quantum states of particles to form a string of zeros and ones. At the same time, any eavesdropping between the sender and the receiver will change this string or key and be noticed immediately. So far, the most common QKD technology uses optical fibres for transmissions over several hundred kilometres, with high stability but considerable channel loss. Another major QKD technology uses the free space between satellites and ground stations for thousand-kilometre transmissions.

QUESS or Mozi/Micius achieved QKD with two ground stations which are 2600 km apart. In 2017, an over 2000
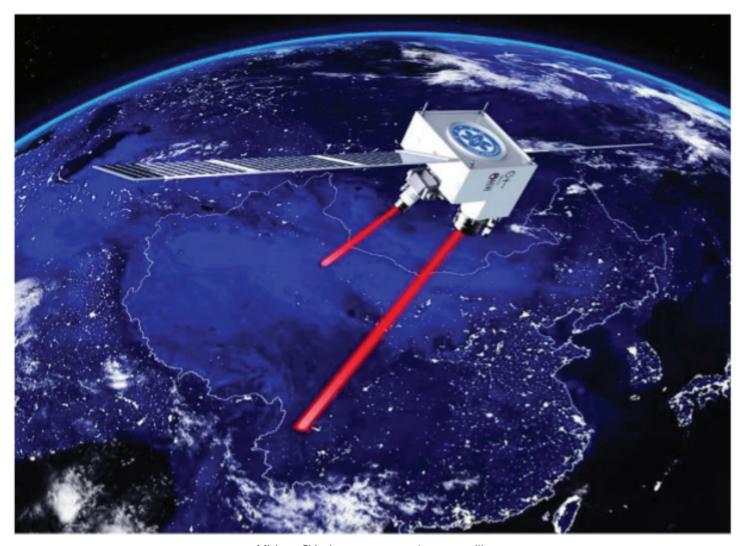
km long optical fibre network was completed for QKD between Beijing and Shanghai.

Using trusted relays, the ground-based fibre network and the satellite-to-ground links were integrated to serve more than 150 industrial users across China, including state and local banks, municipal power grids, and e-government websites. This work shows that quantum communication technology can be used for future large-scale practical applications. Similarly, a global quantum communication network can be established if national quantum networks from different countries are combined. If universities, institutions and companies come together to standardise related protocol hardware.

In recent years, the team extensively tested and improved the performance of different parts of the integrated network. With an increased clock rate and more efficient QKD protocol, the satellite-to-ground QKD now has an average key generation rate of 47.8 kilobits per second, which is 40 times higher than the previous rate. The researchers have also pushed the record for ground-based QKD to beyond 500 km using a new technology called twin-field QKD (TF-QKD).

Next, the team will further expand the network in China and their international partners from Austria, Italy, Russia, and Canada. They also aim to develop small-scale, cost-efficient QKD satellites and ground-based receivers and medium and high earth orbit satellites to achieve all-time, ten-thousand-km QKD.

China's Micius satellite is the world's first quantum communications satellite and has been at the forefront

Micius – China's quantum entanglement satellite

of quantum encryption. It has produced several breakthroughs under its operating team led by Pan Jian-Wei, China's *"Father of Quantum"*.

Micius is operated by the Chinese Academy of Sciences, as well as ground stations in China. The University of Vienna and the Austrian Academy of Sciences are running the satellite's European receiving stations.

The satellite serves as the source of pairs of entangled photons, twinned light particles whose properties remain intertwined no matter how far apart they are.

Micius has previously produced entangled photons and delivered them to two ground stations (observatories) 1200 kilometres apart via special telescopes. Scientists showed the photons reach Earth as entangled as they were in orbit.

Then, in 2017, Micius distributed quantum cryptographic keys to ground stations near Vienna and Beijing, enabling a secure virtual meeting between the Austrian and Chinese science academies - 7400 km apart.

None of the communication went through Micius. It only produced and distributed the encryption keys. Both

ground stations had to talk to and trust Micius as part of their communication systems and use it as a relay before establishing a link with each other.

The launch of Micius in 2016 could have been viewed as merely a single addition to the 2700-odd instruments already orbiting Earth. But Micius, which is solely dedicated to quantum information science, arguably represents the nation's leader in an emerging contest among great powers at the frontiers of physics. The brainchild of physicist Jian-Wei Pan of the University of Science and Technology of China, the satellite has helped him and his colleagues

achieve several ground-breaking results that bring the once esoteric field of quantum cryptography into the mainstream. Pan's team presented a secure method of quantum messaging using Micius in a new paper published in Nature. The achievement brings the world, or China, at least one step closer to realising truly unhackable global communications.

In 2017 the team, along with a group of researchers in Austria, employed the satellite to perform the world's first quantum-encrypted virtual teleconference between Beijing and Vienna. Despite being a huge milestone, this method was not bulletproof against hacking. Micius itself was the weak point: The satellite "knew" the sequences of photons, or keys, for each location, as well as a combined key for decryption. If somehow, a spy had carefully eavesdropped on its activity, the integrity of the teleconference could have been compromised.

To overcome this problem, the new demonstration by Pan and his colleagues ensured that Micius would not "know" anything. The trick was to avoid using the satellite as a communications relay. Instead, the team relied solely on transmitting a pair of secret keys to allow two ground stations in China, located more than 1,120 kilometres apart, to establish a direct link. *"We don't need to trust the satellite,"* Pan says. *"So the satellite can be made by anyone - even by your enemy."* Each secret key is one of two strings of entangled photon pairs. The laws of quantum physics dictate that any attempt to spy on such transmission will unavoidably leave an error-like footprint that recipients can easily detect at either station.

This is the first time the technique, called entanglement-based quantum-key distribution, has been demonstrated using a satellite. (The 2017 test also distributed quantum keys. It did not utilise entanglement to the same degree, however.) *"When the satellite was launched, that was a huge milestone,"* says Shohini Ghose, a physicist at Wilfrid Laurier University in Ontario, who was not involved in the new study. *"But the researchers didn't have the level of error-detection rates that are required to use that entanglement to do key distribution."*

The error-detection rate is vital because distinguishing between an actual error and an error-like footprint from eavesdropping is crucial for security. In addition, a high rate could mean that the keys that two ground stations receive differ from each other - a scenario that would render secure communications impossible. To improve the fidelity of their communications system, the scientists focused on boosting the light-gathering efficiency of telescopes at each of the two ground stations that monitored Micius's transmissions - updating filtering systems and optical components to reach the necessary low error rate required for quantum-key distribution.

Tiangong-2 is China's second Space Laboratory module which was launched on September 15 2016. Tiangong-2 carries a total of 14 mission and experiment packages, including Space-Earth quantum key distribution and a laser communications experiment to facilitate space-to-ground quantum communication.

Researchers of Delft University of technology have put forward a roadmap for quantum internet development.
A quantum internet may very well

be the first quantum information technology to become a reality. Researchers at QuTech in Delft, the Netherlands, published a comprehensive guide toward this goal in Science. It describes six phases, starting with simple networks of qubits that could already enable secure quantum communications—a phase that could be a reality soon.
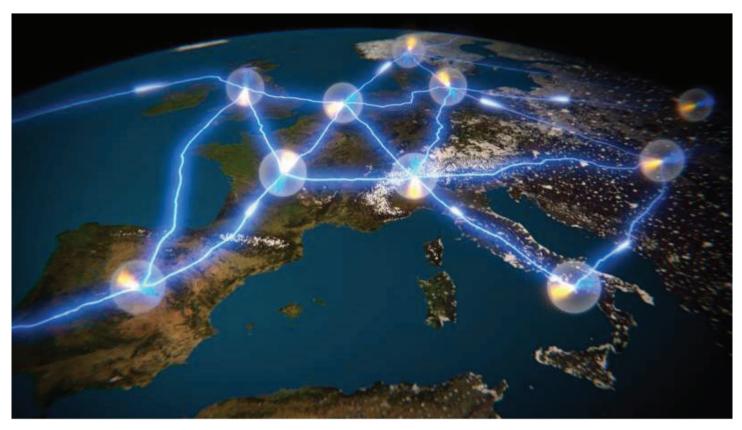
The development ends with networks of fully quantum-connected quantum computers. In each phase, new applications become available such as highly accurate clock synchronisation or integrating different telescopes on Earth in one virtual super-telescope. This work creates a common language that unites the highly interdisciplinary field of quantum networking toward achieving a worldwide quantum internet dream.

WATCH: A brief intro to quantum computers.

Much development in computer software can be expected to exploit the unprecedented capabilities of quantum computing. A new programming language QuGCL has been developed to support programming with quantum case statements, and a family of algebraic laws for quantum programming has been established. QuGCL is a high-level language that can describe quantum algorithms efficiently.

The R&D for quantum computer qubit memory continues. Much hope was placed in Majorana memory, but this now seems to have faded.
A team of Nanjing University academics created a quantum memory in 2019 by trapping billions of rubidium atoms into a hair-like tiny space. Those atoms are cooled down to nearly

Artist impression of a quantum internet in Europe.
Credit: QuTech/TU Delft/Scixel

absolute zero temperature (about 100 pK) using lasers and a magnetic field. The team also found a smart way to distinguish the single photon from the noisy background light sea. The finding brought the dream of a 'universal' quantum computer a step closer to reality. Such quantum memories can also be used as repeaters in a quantum network, laying the foundation for a new generation of quantum-based internet.

A quantum internet will revolutionise communication technology by exploiting phenomena from quantum physics, such as entanglement. Researchers are working on technology that enables the transmission of quantum bits between any two points on Earth.

This brings two features that are out of reach for the internet that we know

today. The first is that entanglement allows improved coordination between distant sites. This makes it highly suitable for clock synchronisation or the linking of distant telescopes to obtain better images. The second is that entanglement is inherently secure. If two quantum bits are maximally entangled, then nothing else in the universe can have any share in that entanglement. This feature makes entanglement uniquely suitable for applications that require security and privacy.

Many other quantum internet applications are already known, and more are likely to be discovered as the first networks come online. Researchers at QuTech collaborate between the Delft University of Technology and the Netherlands for applied scientific research TNO (Nederlandse Organisatie Voor

Toegepast Natuurwetenschappelijk Onderzoek) have now set forth stages of quantum internet development distinguished by technological capabilities and corresponding applications.

The lowest stage of an actual quantum network—a prepare and measure network—allows the end-to-end delivery of quantum bits between any two network nodes, one quantum bit at a time. This is already sufficient to support many cryptographic applications of a quantum network. The highest stage is the long-term goal of connecting large quantum computers on which arbitrary quantum applications can be executed.

In addition to providing a guide to further development, the work sets challenges both to engineering efforts and the development of applications.

"On the one hand, we would like to build more advanced stages of such at the network ever", says Stephanie Wehner, lead author of the work, *"On the other hand, quantum software developers are challenged to reduce the requirements of application protocols so they can be realised already with the more modest technological capabilities of a lower stage."* Co-author Ronald Hanson adds: *"This work establishes a much-needed common language between the highly interdisciplinary field of quantum networking spanning physics, computer science and engineering."*

The first actual quantum networks, allowing the end-to-end transmission of quantum bits, are expected to be realised in the coming years, heralding the dawn of a large-scale quantum internet.

Israel has allocated $60 million to build its first quantum computer. Yaacov Benmeleh (March 3, 2021, 2:07 PM GMT+2) writes:

Israel is seeking to build its first quantum computer, joining a global race for one of the world's most critical emerging technologies.

The Ministry of Defence and Innovation Authority is taking bids from multinational companies, Israeli businesses and universities for a 198 million-shekel ($60 million) project to build a computer with 30 to 40 qubits, according to Aviv Zeevi, vice president at the Authority's Technological Infrastructure Division. He expects the winner of the tender to begin work before the end of the year.

"We want to be in the game," Zeevi said. *"We need to be at least at a reasonable level to be able to develop varying kinds of hardware and software associated with quantum computers.*

Rather than storing information in binary 0s or 1s, like classical computers, a quantum computer's qubits can be both 0 and 1 simultaneously, which translates into an exponential edge in computing power."

In 2019, Google claimed that its quantum computer solved a problem in minutes that would have taken the fastest supercomputer about 10,000 years.

The new project is part of Israel's 1,25-billion-shekel national initiative to build up quantum proficiency. While scientists say practical, widespread applications for quantum computers are still years away, countries like China, the US and Germany are devoting large sums to master this technology.

Israel is a tech powerhouse home to several dozen so-called unicorns or privately-owned tech firms worth over $1 billion. But there are only a handful of quantum computing start-ups, such as the software firm Classiq Technologies and Quantum Machines, which develops hardware and software for quantum computers.

[Click here](#) for Quantum Machine's website.

The government initiative *"is a massive first step,"* said Itamar Sivan, chief executive officer of Quantum Machines. *"We hope that with continued investments, we can grow the burgeoning quantum ecosystem here."*

In the US, the National Institute of Standards and Technology NIST has announced four programs for the advancement of quantum technology:

- Optical Networking of Superconducting Quantum Nodes with Transduction Devices

- Quantum Transport Measurements
- Electronic Material Characterization
- Quantum Communications and Networks

The Quantum Communication and Networks Project develops quantum devices and studies them for use in quantum communications and networking applications. Our goal is to bridge the gap between fundamental quantum mechanics/information theory and their practical applications in information technology.

Our research covers two areas:

1. We perform research on the creation, transmission, transduction/interfacing, storage, processing and measurement of optical qubits – the quantum states of single photons. We build and study quantum devices, such as entangled-photon sources, single-photon detectors, optical quantum memory and quantum transduction interfaces. A long term goal is to apply these devices to quantum systems such as a quantum repeater.

2. We are working toward implementing a quantum network testbed. The suitability and performance of new and existing quantum devices and systems can be studied in a real-life network environment. The testbed will lead to the development of best practices and protocols for quantum networks.

To stay on track with ever-increasing data being sent from space to Earth, NASA announced that it would be testing laser communication systems starting this summer. This is not qubit communication but will nevertheless provide much faster data transfer.

Space missions are seeing new technologies and instruments capable of gathering more data than ever before. So to send this data back to Earth as quickly and safely as possible, NASA plans to move away from the current and traditional radio frequency communications and instead welcome laser communications, also known as optical communications. The laser beams will not require encryption but will need to be accurately directed towards planet Earth.

On May 12, NASA announced that its Laser Communications Relay Demonstration (LCRD) would launch this summer to showcase the power of these technologies.

UK Research and Innovation, through the Engineering and Physical Sciences Research Council (EPSRC) and the Science and Technologies Facilities Council (STFC), is leading a programme to establish the National Quantum Computing Centre (NQCC) as part of phase 2 of the National Quantum Technologies Programme (NQTP).

The NQCC will build the UK's capability to be at the forefront of quantum computing, delivering greater prosperity and security advantages for the UK, as announced in the Budget in November 2018.

The NQCC will be a dedicated national centre to work towards fully scalable, fault-tolerant, general-purpose quantum computing.

For more information about the centre, visit the NQCC's official website.

When discussing photon quanta and entanglement, it is pretty easy to mention single quanta without appreciating the minimal values involved.

Let us take a photon quantum of red light – 650 nm wavelength and 461 THz frequency.

With a Planck constant of 6,62607 x 10^{-34} Js, this will have an energy of 0,30546 x 10^{-18} J giving 3,27375 x 10^{18} photon quanta per joule.

A joule is a small quantity of energy – one watt for one second.

A sphere the size of the Earth has a surface area of 510,1 x 10^{12} m^2.

Let us now imagine that we could spread a joule of photon quanta evenly over this sphere.

This will give us 6418 quanta per square metre.

A photon is a quantum of energy that cannot be visualised. However, it gives us sight by streaming into our eyes in millions per microsecond.

A gamma-ray photon can have wavelengths of less than a picometre, and a low-frequency radio wave can have wavelengths of thousands of kilometres.

Quantum computers and quantum communications present exceptional opportunities for further research and development. **wn**

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PoPI and Covid-19

- DATA STRATEGIES HAVE TO ADAPT TO CHANGE

The way companies view and approach Disaster Recovery (DR) and Business Continuity (BC) strategies have changed drastically in the past year, primarily due to the Protection of Personal Information Act (PoPI) which will come into effect from July 2021. Usually, DR and BC are considered critical in natural disasters, hardware failure and cybercrime to ensure the business can continue with minimal disruption. However, the pandemic has amplified the need for backup and recovery.

BY | CHRIS DU BRUYN, OPERATIONS DIRECTOR AT GABSTEN TECHNOLOGIES

This is because, with most employees now working from home (WFH) and the increase in endpoint devices used outside of the traditional office environment, data management requirements will need to be aligned with the PoPI Act. Compliance in the face of all this change is much easier to achieve with the right IT partner who can assist with understanding what data the organisation has and where it's stored. Only by effectively understanding their data can companies achieve compliance with the PoPI Act.

2020 VS 2021: WHAT'S CHANGED?

Before the Covid-19 lockdown that started in March 2020, companies had data pipelines running on premises. Their footprint was small, and even with the cloud in play, everyone had

a clear understanding of who was responsible for information and data as it passed through the organisation. Then suddenly, social distancing became the norm, and everyone was forced to work from home, and things got complicated. With thousands of people now working from home, mostly on public networks, on-premises strategies have had to change to ensure that business and confidential information is secured and handled in a compliant manner. Now, everything is primarily cloud-based, and companies have had to ensure that the data they are protecting from home or remote locations is secure up to the point where it moves into the cloud.

Compliance starts with understanding Now, more than ever, companies

must grasp that they will not achieve compliance without understanding what data they have, mainly if it's personal information. Additionally, companies must ensure the data they have, whether backup or production, is secure. While this is one of the biggest challenges with WFH, some things haven't changed, and the 3-2-1 backup rule is still relevant here.

Companies need to keep at least three (3) copies of their data and store two (2) backup copies on different storage media, with one (1) located offsite. With PoPI, the offsite requirement becomes critical, particularly in light of PoPI's requirement that this offsite data be stored locally. With so many companies moving to the cloud, they must determine precisely where the data is hosted.

Heightened compliance requirements It's important to remember that organisations are accountable for their data, primarily if their employees work from home. Although WFH does not absolve the company of responsibility for data protection, the company must find a way to ensure that their data is secure, irrespective of where it is stored and moved.

Companies will also have to re-assess their entire data management strategy and processes to ensure that personal information is handled correctly and that it is destroyed in line with the time requirement of PoPI, which limits the amount of time for which personal information can be kept. Destruction of information is essential, and companies need to have a clear plan as to how they're going to do it,

especially when it comes to backups. To ensure that they do not fall foul of PoPI and avert the legislative penalties, companies must ensure their data is secure. Staff training regarding PoPI is vital to ensure that employees are adequately informed on the legislative requirements and understand what processing limitations apply to the data they handle every day.

Additionally, businesses need to consider their data quality to eliminate information that is no longer relevant to the company. They will need to obtain data subject opt-in, which includes informing the data subjects what information is held on them, what purpose and when the data will be destroyed. Further complicating the situation is that PoPI enables data subjects to request that their

data be destroyed. This means that any company holding data about that individual needs to immediately find, identify and destroy that information, even at a backup level.

POPI SHOULDN'T COME AS A SURPRISE

Organisations have had more than enough time to prepare for PoPI's arrival, as it's been on the cards for several years already.

However, given that the effective date is July 2021, those organisations that have not yet got their compliance ducks in a row would do well to choose a data services partner that can help them meet all the necessary DR and BC requirements while facilitating and securing the new norm of working from home. **wn**

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06/07/2021	Women In Engineering - Engineering Heroes	-
06/07/2021	Planning Strategic Feasibility Studies	3
07/07/2021	Mpumalanga Centre webinar: Principles of Practical Machine Learning	TBC
13/07/2021	Fundamentals of Lighting Design	3
15/07/2021	KZN Centre webinar: 100 MW limit and associated Grid-Tie considerations	TBC
15/07/2021	ARC Flash	2
20/07/2021	SDN/NFV Standards and Applications	2
20/07/2021	Fundamentals of Financial Evaluation of Projects	3
26/06/2021	Eastern Cape Centre Short Talk - via MSTeams: Renewable Energy in the South African Electricity Mix	-
27/07/2021	Nuclear Chapter webinar: Study Committee on Nuclear Energy	TBC
27/07/2021	Legal Liability Mine Health and Safety Act (Act 29 Of 1996)	2
28/07/2021	Run Your Project as A Business	1
28/07/2021	Design of Economical Earthing Systems for Utility Electrical Installations	2
28/07/2021	Power System Protection	3
29/07/2021	SANS 10142–1 (Edition 3)	2

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