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Google's AI Matryoshka: restructuring the search giant

The technology behemoth's recent I/O conference revealed a layered AI strategy, promising immense power but also raising profound questions about data, intellectual property, and user privacy

John Xavier

Google's annual I/O developer conference in 2025 was less a showcase of disparate product updates and more a systematic unveiling of an AI-centric future. The unspoken theme was that of a Matryoshka doll: at its core, a refined and potent artificial intelligence, with each successive layer representing a product or platform drawing life from this central intelligence. Google is not merely sprinkling AI across its offerings; it is fundamentally restructuring its vast ecosystem around it. The result is an increasingly interconnected and agentic experience, one that extends to users, developers, and enterprises alike, prompting a re-evaluation of the firm's responsibilities concerning the data that fuels this transformation.

"More intelligence is available, for everyone, everywhere," declared Sundar Pichai, CEO of Google and its parent company, Alphabet. "And the world is responding, adopting AI faster than ever before." This statement signals a push towards a more intelligent, autonomous, and personalised Google. Yet, as each layer of this AI Matryoshka is peeled back, the data upon which this intelligence is built, the copyrighted material ingested by its models, and the implications for user privacy are brought into sharper focus, forming a critical, if less trumpeted, narrative.

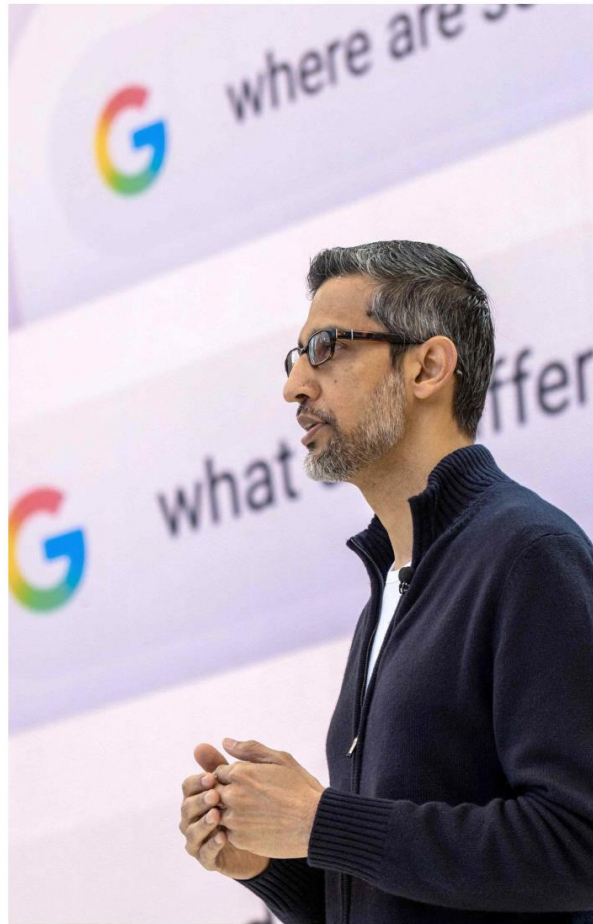
It has been nearly two years since Satya Nadella of Microsoft described Google as an "800-pound gorilla" challenged to perform new AI tricks. Google's response, particularly evident at I/O 2025, suggests the gorilla is learning to pirouette.

At the innermost core of Google's AI strategy lie its foundational models. The keenly awaited Gemini 2.5 Flash and Pro models, now nearing general availability, represent more than incremental improvements; they are a refined engine for AI experiences. The "enhanced reasoning mode in Gemini 2.5 Pro," dubbed Deep Think, leverages parallel processing, demonstrates impressive capabilities in complex mathematics and coding, even achieving a notable score on the 2025 USAMO, a demanding mathematics benchmark. While Deep Think will initially be available to select testers via the Gemini API, its potential to grapple with highly complex problems signals a significant advancement in AI reasoning.

Workhorse upgraded

Gemini 2.5 Flash, the workhorse model, has also received substantial upgrades, purportedly becoming "better in nearly every dimension." It boasts increased efficiency, using 20-30% fewer tokens (the units of data processed by AI models), and is set to become the default in the Gemini application. These models, enhanced with native audio output for more naturalistic conversational interactions in 2.5 Pro and Flash, and a pioneering multi-speaker text-to-speech function supporting two voices across 24 languages, constitute the powerful nucleus from which all other AI functionalities radiate.

This computational prowess is built



Complete change: Google CEO Sundar Pichai addresses the crowd during Google's annual I/O developers conference in Mountain View, California on May 20, 2025. AFP

upon Google's proprietary Tensor Processing Units (TPUs). The seventh generation TPU, Ironwood, is said to deliver a tenfold performance increase over its predecessor, offering a formidable 42.5 exaFLOPS of compute per pod. Such hardware forms the bedrock for training and deploying these sophisticated AI systems.

However, the very power of these generative models, especially Imagen 4 and Veo 3 for visual media, and Lyria 2 for music generation, necessitates a closer look at their training data. The creation of rich, nuanced outputs depends on ingesting colossal datasets.

Persistent industry-wide concerns revolve around the use of copyrighted material without explicit consent or remuneration for original creators. Google highlighted tools such as SynthID, designed to watermark AI-generated content, and a new SynthID Detector for its verification. Yet, these are mitigations, not comprehensive solutions, to the intricate and ongoing debate surrounding copyright and fair use in an era increasingly defined by generative AI. The

provenance and fiduciary responsibility over the data remain complex issues.

Platform proliferation

One layer out from the core models are the platforms and APIs that democratise access to this AI. The Gemini API and Vertex AI are pivotal here, serving as the primary conduits for developers and enterprises. Google aims to improve the developer experience by offering "thought summaries," providing transparency into the model's reasoning, and extending "thinking budgets" to Gemini 2.5 Pro, giving developers more control over computational resources.

Critically, native software development kit (SDK) support for the Model Context Protocol (MCP) has been incorporated into the Gemini API. This represents a significant move towards fostering a more interconnected ecosystem of AI agents, enabling them to communicate and collaborate with greater efficacy by sharing contextual information. This inter-agent communication, while powerful, also introduces new vectors for data security considerations, as

information flows between potentially diverse systems. Project Mariner, a research tool, is also being integrated into the Gemini API and Vertex AI, allowing users to experiment with its task automation capabilities.

AI meets the user

The outermost layers of Google's AI Matryoshka are where users most directly encounter AI, often without fully comprehending the sophisticated infrastructure beneath. This is where Google is reimagining search, commerce, coding, and application integration.

The "AI Mode" in Search, scheduled for rollout to users in the United States, will offer enhanced reasoning and multimodal search capabilities, powered by a customised version of Gemini 2.5. A feature within this mode, Deep Search, is designed to generate comprehensive, cited reports. The quality and impartiality of these citations, especially when generated by AI, will be an area for careful scrutiny.

Within AI Mode, a novel shopping experience will allow users to virtually try on clothes by uploading their own photographs. Once a product is selected, an "agentic checkout" feature, initially available in the U.S., promises to complete the purchase. Such a feature inherently requires access to sensitive personal and financial data, raising questions about data minimisation, security, and the potential for profiling.

The all-in-one app

The Gemini application itself is being significantly augmented. The Live feature is now generally available on Android and iOS, and the app incorporates image generation. For subscribers to the new Google AI Ultra tier, the app will feature the latest video generation tool, complete with native audio. A "Deep Research" function within the app can now draw upon users' private documents and images. While potentially offering powerful personal insights, this feature dives deep into personal data pools, demanding robust privacy safeguards and transparent consent mechanisms. How this data is firewalled, processed, and protected from misuse or overreach will be paramount.

Canvas, the creative workspace within Gemini, has been made more intuitive with the Gemini 2.5 models, facilitating the creation of interactive infographics, quizzes, and even podcast-style Audio Overviews in 45 languages. Furthermore, Gemini is being integrated into the Chrome browser (initially for Pro and Ultra subscribers in the U.S.), enabling users to query and summarise webpage content.

For developers, the new asynchronous coding agent, Jules, is now in public beta globally where Gemini models are accessible. It integrates directly with existing code repositories, understanding project context to write tests, build features, and rectify bugs using Gemini 2.5 Pro.

Mr. Pichai's "new phase of the AI platform shift" is undeniably underway. Google's introduction of a new Google AI Ultra subscription tier offers users differentiated access to its most advanced AI capabilities. This stratification, however, prompts questions about whether the most robust privacy-enhancing features or responsible AI controls will be universally available or if a "privacy premium" could emerge, where deeper safeguards are reserved for paying customers. As Google rearchitects itself around AI, the intricate dance between innovation, utility, and the stewardship of data will define its next chapter. The layers of the Matryoshka are still being revealed, and with each one, the responsibilities grow.

Why has Tamil Nadu adopted a space sector policy?

What does the southern State's Space Industrial Policy hope to achieve? Will it generate employment?

T. Ramakrishnan

The story so far:

In April 17, the Tamil Nadu Cabinet, at a meeting chaired by Chief Minister M.K. Stalin in Chennai, approved the Space Industrial Policy, thereby following Karnataka and Gujarat in formulating a State-specific document to stimulate development and woo investments in the space sector, which encompasses satellite manufacturing, launch services, and satellite services. In 2023, the Union government came out with the Indian Space Policy 2023 to provide a framework to support the space ecosystem.

How is Tamil Nadu placed?

The Indian Space Research Organisation (ISRO) has established an ISRO propulsion complex (IRPC) in Mahendragiri of Tirunelveli district. Apart from handling and testing earth storable propellant

engines, cryogenic engines and stages for launch vehicles, the IRPC conducts research and development (R&D) and technology development programmes. ISRO is also establishing the country's second spaceport at Kulasekarapattinam in Thoothukudi. This strategic initiative aims to enhance India's space capabilities and facilitate satellite launches. The State is also home to various space startups, which are working on subdomains such as launch vehicles, reusable launch vehicles, in-space refuelling, in-space manufacturing and multi-payload data fusion from satellites, as per the Space Industrial Policy. Additionally, the National Institute of Technology (NIT), Tiruchi, hosts the southern region's Space Technology Incubation Centre (STIC), playing a pivotal role in undertaking developmental projects of the ISRO.

What triggered the policy?

The Indian National Space Promotion and

Authorisation Centre (IN-SPACe), a body created by the Department of Space at the Centre for promoting, authorising and overseeing the activities of Non-Government Entities (NGEs) in the sector, had suggested to the State government to come out with a document, says a senior official.

Even as the State government produced the Aerospace and Defence (A&D) Industrial Policy three years ago, it identified space as one of the priority areas. Additionally, the State has a vendor base with over 250 vendors catering to the requirements of the ISRO. The Tamil Nadu Industrial Development Corporation (TIDCO) has signed a Memorandum of Understanding with IN-SPACe to enable startups and established companies to launch manufacturing related activities and services, design and R&D, strategic electronics manufacturing and space-grade components.

What does Policy want to achieve?

Aimed at attracting ₹10,000 crore investments in the next five years, the document, according to the government, may pave the way for the generation of direct and indirect employment for nearly 10,000 persons in the given period.

The Policy has been prepared, keeping in mind the need for leveraging the State's strengths in electronics, precision manufacturing and related sectors, and integrating space technologies into Tamil Nadu's governance to improve citizens' quality of life. Space technologies have immense applications in departments such as disaster management, fisheries, agriculture, transport, revenue, health, and municipal administration.

The State government would provide a payroll subsidy for companies that are involved in R&D or that would establish global capability centres in the space sector. The government will also notify select regions as Space Bays for offering structured packages of incentives to firms that plan to do investments below ₹300 crore. Additionally, space industrial park developers will be eligible for an industrial housing incentive of 10% on the cost of developing residential facilities within the industrial park over 10 years, subject to a ceiling of ₹10 crore. Those undertaking green and sustainable initiatives will be eligible for a 25% subsidy on the cost of capital for such initiatives, subject to a ceiling of ₹5 crore.

THE GIST

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Time for a new India-Africa digital compact

Africa Day (May 25) marks the founding of the Organisation of African Unity in 1963 and symbolises the continent's ongoing journey towards unity, independence, and development. To usher in a new era of growth, the African Union's Digital Transformation Strategy (2020-2030) positions digital innovation at the heart of its agenda. It recognises the need for governments to adopt digital solutions that can accelerate socio-economic progress.

This evolving paradigm is also reshaping India's approach to development diplomacy in Africa. For decades, India has blended state-led financing with socially embedded solutions, ranging from capacity-building through technical training to infrastructure projects backed by concessional lines of credit. Increasingly, social enterprises delivering low-cost, high-impact innovations have also become part of New Delhi's engagement, reflecting a shift toward more inclusive and adaptable partnerships.

A digital partnership

India's development approach is now entering a new phase, marked by more integrated, technology-driven partnerships. This builds on early initiatives such as the Pan-African e-Network, launched in 2009, which provided tele-medicine and tele-education through satellite and fibre-optic infrastructure, implemented by TCIL on behalf of the Indian government.

Expanding on this, and building on the success of its Digital Public Infrastructure (DPI) systems, such as Aadhaar, UPI, CoWIN, and DIKSHA, India is now focusing on sharing and co-creating digital solutions to tackle fundamental governance and service delivery challenges. This shift comes at a crucial moment for Africa, where many governments are advancing national and continental digital agendas, aligned with initiatives such as the Policy and Regulatory



Veda Vaidyanathan

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A new India-Africa digital compact, anchored in mutual respect, co-development, and long-term institutional partnerships, could serve as a scalable framework for advancing digital inclusion

Initiative for Digital Africa and the Smart Africa Alliance, aimed at harnessing technology for inclusive and sustainable development.

The contours of a digital partnership between India and Africa are already emerging. In 2021, Togo's National Agency for Identification signed an MoU with the International Institute of Information Technology Bangalore (IIIT-B) to implement the Modular Open-Source Identification Platform as the foundation for its national digital ID system. In 2023, Zambia signed an MoU with the Centre for Digital Public Infrastructure at IIIT-B to support the implementation and scaling up of the Smart Zambia Initiative, a national effort to advance digital transformation across government services. In 2024, the Bank of Namibia signed a pact with the National Payments Corporation of India for developing a UPI-like instant payment system. Ghana, too, is linking its payment system with India's UPI to enable faster transactions. These partnerships reflect a growing interest in India's DPI model, which offers affordability, scalability, and a public-oriented design.

However, these advances of India's digital diplomacy in Africa are not occurring in a vacuum. As research by Folashadé Soulé highlights, African governments typically choose digital partners not based on ideological alignment or geopolitical loyalty, but on the partner's capacity to meet national digital priorities. In this context, China has frequently emerged as a preferred collaborator, thanks to state-backed financial mechanisms that lower the cost of adoption, especially in infrastructure-heavy domains. But it is not alone in shaping Africa's digital future: the European Union, the U.S., and India are competing for influence. What sets India apart is not just its technology, but its framing of DPI as a digital public good, open-source, and adaptable.

India's DPI model offers a public-oriented alternative to a more surveillance-driven or proprietary approach. The opportunity lies in adapting these tools to local contexts through genuine state-led collaboration, beyond technology transfer.

In this context, the establishment of the first overseas campus of the Indian Institute of Technology Madras in Zanzibar represents a strategic intervention. By offering advanced academic programmes in Data Science and AI and integrating with Indian private sector partners to fund scholarships, the initiative aligns technical capacity-building with broader socio-economic goals. If scaled effectively, such models could power Africa's digital infrastructure.

Challenges

However, challenges persist. Africa is home to the world's largest digital divide. This exclusion is shaped by the high costs of data and devices, stark rural-urban disparities in connectivity, and a persistent gender gap in digital access and literacy. Moreover, the expansion of digital infrastructure hinges on reliable energy supply, a critical bottleneck in many African countries. Meeting the growing energy demands of digital transformation will require coordinated investments in sustainable power generation and grid expansion.

Regardless, the groundwork for digital governance is advancing. About 85% of African countries now have national ID systems with digital capabilities, and over 70% collect biometric data for authentication purposes. This presents a strong foundation on which to build inclusive and interoperable public digital platforms. A new India-Africa digital compact, anchored in mutual respect, co-development, and long-term institutional partnerships, could serve as a scalable framework for advancing digital inclusion.

The air power use discourse and Operation Sindoor

Whenever nations embark on reconfiguring their security strategies, they must invariably review the use of the various instruments of force that are available for exploitation. India's journey down that road has been evolutionary rather than transformational. From a rather diffident power soon after Independence, that perceived the instrument of force as an 'avoidable necessity', to more assertive expressions of national power over the last five decades, that commenced with the 1971 war with Pakistan, Indian statecraft stands at the crossroads of a new era.

The 'new normal'

Operation Sindoor (May 7-10) may well have redrawn the contours of India's unwritten national security strategy. Here, at its centre, is a more assertive and proactive strategy that is now willing to explore 'prevention, pre-emption and punishment' as the new normal against Pakistan, should it continue to support terrorism against India as an instrument of the Pakistani state. However, what will hopefully remain as the inviolable edifice of this strategy will be the continuation of 'responsibility and restraint' (the hallmark of any response that the Indian state has offered whenever faced with a national security crisis).

In the past, an excessively continental mindset, a preoccupation with attrition warfare along long and contested borders, and the linkages between conventional operations and territory as a currency of military effectiveness, ensured that land forces, both military and paramilitary, occupied pole position in India's national security calculus. The widespread prevalence of internal armed conflict added to the inescapable necessity for this orientation.

The reemergence of the maritime domain and its attractiveness to double-bank as an instrument of force and diplomacy lifted the blinkers off centuries of sea-blindness and offered options other than a continental mindset to India's national security planners. However, all was not well when it came to understanding the competitive advantage that air power offered



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The focus must be on what air power can bring to an integrated battle to force decisive strategic outcomes

apex policymakers when confronting the dilemmas of climbing the escalation ladder *vis-à-vis* unpredictable adversaries such as Pakistan and matching the capabilities of China (which now appears to have significantly widened the conventional gap with India in all realms of military power, especially air power).

Air power use and what has changed

It is in this context that the recent offensive-defensive employment of air power in Operation Sindoor paves the way for a more nuanced understanding of the importance of military air power in the national security calculus. For over a decade now, the non-kinetic capability of the Indian Air Force (IAF) has matched the best in the world in areas such as tactical and strategic airlift, and Humanitarian Assistance and Disaster Relief (HADR) operations. It is in the offensive realm that the IAF, over the last decade or so, has been attempting to impress upon the strategic establishment that it has the capabilities and the will to act as the first responder and cause significant attrition to an adversary in several new configurations of warfare that are proliferating across the globe.

Until Operation Sindoor, offensive air power was considered by a conservative and diffident strategic establishment in India as an escalatory instrument that fitted only into the calculus of conventional military operations. Even though the IAF doctrine of 2012 articulated the mission requirements of sub-conventional conflict that include counter-terrorist operations, it mainly remained in the realm of discussion in war colleges till the Narendra Modi government decided to use offensive air power at Balakot (in 2019). The IAF, however, remained doctrinally persistent when it continued to push for greater involvement in limited conflict and no-war-no-peace situations in its latest doctrine.

In an era of a serious budgetary squeeze, the past few years have seen fierce competition between the three services (the Indian Army, Indian Navy and IAF) for a share of the defence budget, a situation that has also resulted in dissonance in crafting the optimal military strategy against collusive adversaries with the

available instruments. In this milieu, the IAF has been a laggard in educating and convincing policymakers that offensive air power offers immense potential in waging non-contact warfare and can impose serious costs on adversaries in several contingencies without needlessly committing boots on ground.

What the discourse should be

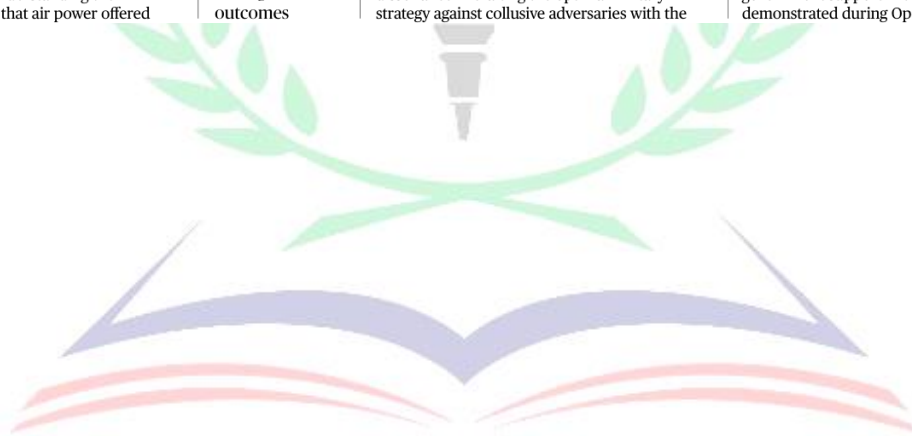
Notwithstanding the success of offensive air power and integrated air defence operations during Operation Sindoor, the four-day conflict cannot serve as a standard template for imposing costs on Pakistan, or on inflicting unacceptable attrition on other adversaries in limited conflict scenarios.

However, what it certainly does is to grant the IAF an equal role in multi-domain operations. The discourse must not be about air power displacing land or maritime power as the pre-eminent instrument in the prevailing complex security environment that India finds itself in. It must be more about what air power can bring to the integrated battle to force decisive strategic outcomes.

Based on the Prime Minister's recent articulation on India's reduced threshold to accept pain, and if its response mechanisms gravitate more towards prevention, pre-emption and punishment strategies, it is a no-brainer that offensive air operations delivered at the tactical and operational levels that produce strategic outcomes will become the Indian military's first responder. Concurrently, a robust and integrated air defence ecosystem that can absorb a peer adversary's natural retaliatory response, will be a significant force multiplier.

With its current capital budgetary allocation to build robust air power capability at very modest levels, the biggest challenge for the IAF is to build the capability to focus on collusive threats that are morphing in the neighbourhood such as the imminent delivery of fifth generation fighter aircraft (the J-35 by China) to the Pakistan Air Force.

The IAF has much catching up to do with government support if it is to fulfil the potential it demonstrated during Operation Sindoor.



Frontier of progress

India must recognise the northeast's diversity to tap its potential

That unity in diversity is India's strength might sound clichéd, but it is as true as ever. Prime Minister Narendra Modi, while speaking at the Rising North East Investors Summit 2025 last week, cited the diversity of India's northeastern region to underscore the vast diversity of the country. The northeast is rich in its cultural diversity and natural resources, and its location, topography and complex histories make it a unique space. But its numerous linguistic, tribal and cultural affinities can be a source of conflict within the Indian state. At times, these conflicts can be violent as the one in Manipur, which erupted on May 3, 2023, and is still simmering between the Kuki and Meiti communities. The Modi government and State governments in the region have sought to turn the region into an attractive destination for investors and tourists. The Sela Tunnel in Arunachal Pradesh, the Bhuben Hazarika bridge in Assam, the construction of 11,000 kilometres of highways, extensive new rail lines, more airports, the development of waterways on the Brahmaputra and Barak rivers, the expansion of mobile telephony, and a 1,600-km-long Northeast Gas Grid are examples of the new dynamism of the region. The Modi government has built on the initiatives of its predecessor United Progressive Alliance governments.

Mr. Modi has also sought to settle many a conflict in the region in the last decade. The Framework Agreement with the NSCN (Isak-Muivah) in August 2015, although nebulous now, the Bodo Peace Accord and the Bru refugee settlement (both in January 2020), and the rollback of the Armed Forces (Special Powers) Act from a larger part of the region have been some of the steps signalling the Centre's intent. The change in perception about the northeast and its green cover has led to a surge in tourism and attracted investments, headlined by the Tata Group's ₹27,000-crore semiconductor plant coming up in Assam. But the challenges remain. Apart from Manipur, there is the perception in Nagaland that the Centre has lost interest in the peace process. Inter-State border disputes also continue to haunt the region, although Assam has partially resolved its issues with Arunachal Pradesh and Meghalaya. The investments have increased the demand for power and the focus on hydroelectric projects, most in Arunachal Pradesh, has triggered local protests fearing displacement and environmental damage in a region that is prone to natural disasters. Increased rhetoric by the Bharatiya Janata Party about immigrants from Bangladesh and Myanmar has heightened social tensions. If India has to meaningfully pursue its Act East policy, by integrating the northeast more closely with the east Asian economies, then its policies within the borders and toward the neighbouring countries should be in alignment.



The maths of how India's coastline lengthened without gaining land

The coastline paradox reveals more than a peculiar measurement challenge: it underscores how science evolves with better tools. What once appeared to be a fixed value turns fluid when examined more closely – not because the coast moved but because our eyes sharpened. India's redefined 11,099-km coastline is a testament to this progress

C. Aravinda

In December 2024, the Union Ministry of Home Affairs made an important announcement as part of its 2023-2024 annual report. It said the length of India's coastline had increased from 7,516.6 km to 11,098.8 km, and that the length is also currently under review.

The 7,516.6 km figure was first recorded in the 1970s based on measurement techniques available at the time. The new revised figure wasn't prompted by any territorial expansion through new land/island annexation or geological upheaval, like tectonic activity stretching the shores. The last coastal State to join the Union of India was Goa in 1961 and the only other State that joined after – Sikkim in 1975 – is landlocked. The enclaves India exchanged with Bangladesh in 2015 also lie deep inland.

So what changed? The root of the discrepancy lies in geometry, in a problem called the coastline paradox. The previous estimate from the 1970s banked on maps that displayed India's coastline at a 1:4,500,000 resolution, which is too coarse to capture intricate features like estuaries, tidal creeks, sandbars, and coastal ridges. Many island groups, particularly the Andaman & Nicobar and Lakshadweep, also hadn't been comprehensively mapped or included.

The more recent updated measurement – performed by the National Hydrographic Office (NHO) and the Survey of India – used electronic navigation charts at a much finer scale of 1:250,000. Preparing these charts requires the use of technologies like geographic information systems, satellite altimetry, LIDAR-GPS, and drone-based imaging. The government has also said the coastline length will be revised every 10 years from 2024-2025, as per the report.

The Survey of India used highwater lines prepared by the NHO based on 2011 data on electronic navigation charts to measure the coastline. The highwater line was used as the base reference and river mouths and creeks were closed off at a fixed threshold inland. The review also included islands exposed to low tide.

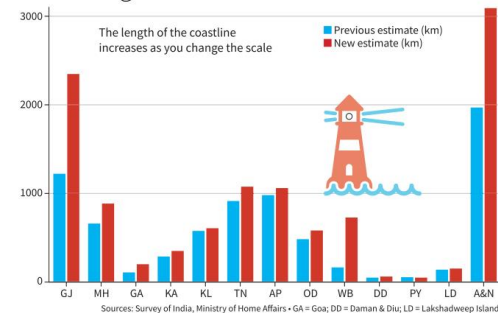
But for all these advances, there is a limitation – and that comes from geometry.

The coastline as puzzle

What's the difference between straight lines and ragged curves?

In Euclidean geometry, the length of a straight line is the shortest distance

The coast grows



In the 1960s, Benoit Mandelbrot found that coastlines exhibit properties similar to fractals. PRIYANSHU PATIDAR/UNSPASH

between two points at the ends of the line. Curves on the other hand are measured by their geodesic length: i.e. the length along the surface of the curve.

But what happens when the curve itself is irregular, jagged, and ever-changing the way a coastline is when it's shaped by river mouths, creeks, delta formations, etc.?

The problem becomes harder when one attempts to draw a boundary at a river mouth: should it be marked at the ocean opening or traced further inland? Such ambiguities add to the complexity together with constant tidal fluctuations and shifting sedimentation.

This is where traditional measurement concepts break down and the choice of

scale becomes decisive.

The coastline paradox

The British mathematician and physicist Lewis Fry Richardson first identified the coastline paradox in the early 1950s. His Polish-French peer Benoit Mandelbrot examined the problem mathematically in 1967 and also popularised it. Mandelbrot found that coastlines exhibit properties similar to fractals.

In a landmark paper entitled 'How Long is the Coast of Britain?', Mandelbrot explored why the length of Britain's coast varied dramatically depending on the length of the measuring stick. Using different ruler sizes on a map, he found that Britain's coast could vary from

Hypothetically, using a measurement unit the size of a water molecule would result in a coastline length approaching infinity

around 2,400 km to more than 3,400 km – a striking range for a fixed landmass.

Note that coastlines are not true fractals in the pure mathematical sense but display fractal-like properties. To describe fractals, scientists use the concept of fractal dimension, a number that denotes the degree of complexity a shape exhibits as one zooms into it.

For example, measuring a coastline with a 200-km-long ruler would smooth over most inlets and bays – but a 50-km ruler would detect them. At 1 km, the measurement will capture every estuary, tidal flat, and creek. So the more one refines the scale of the ruler, the longer the total coast becomes.

Hypothetically, using a measurement unit the size of a water molecule would result in a coastline length approaching infinity. This dependence on scale underscores the inherent paradox: a finite piece of geography yielding a seemingly infinite measurement in cartography.

Implications for security, fishing

The change in length is not just a mathematical curiosity or an academic pursuit. The length of India's coastline influences maritime security plans, disaster preparedness (especially for cyclones and tsunamis), and fishing rights.

A longer coastline obviously means a longer length to protect but it also means a longer economic zone. India has 11 coastal States and two large island groups, faces regular cyclones, and is especially vulnerable to sea-level rise. Understanding the true extent of the national coast can thus help refine climate models, coastal zoning regulations, and disaster response strategies.

In the same vein, high-school geography textbooks may need to be revised as well.

The coastline paradox also reveals more than a peculiar measurement challenge: it underscores how science evolves with better tools. What once appeared to be a fixed value turns fluid when examined more closely – not because the coast moved but because our eyes sharpened. India's redefined 11,099-km coastline is a testament to this progress.

(C. Aravinda is an academic and public health physician. The views expressed are personal. aravindaaimsjr10@hotmail.com)

THE GIST

The root of the discrepancy lies in the coastline paradox. The previous estimate banked on maps that displayed the coastline at a 1:4,500,000 resolution, which is too coarse to capture intricate features. The updated measurement used a much finer scale of 1:250,000.

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The length of India's coastline influences maritime security plans, disaster preparedness, and fishing rights. A longer coastline obviously means more area to protect, but it also means a longer economic zone.

Meghalaya's new cave-dwelling fish adapts to streams overground: study

Rahul Karmakar
GUWAHATI

An underground cave in Meghalaya, in focus for a conflict over a Shivalinga-like stone formation, has yielded a new-to-science fish that adapts to streams overground.

A team of zoologists, led by Kangkan Sarma of Gauhati University's Department of Zoology, has recorded *Schistura densiclava* as a new species of troglophile loach from Krem Mawjymbuin in the State's East Khasi Hills district.

A troglophile animal is essentially a cave-dwelling animal that can thrive and reproduce in epigean, or aboveground, environments.

Mr. Sarma and D. Khlur Baiaineh Mukhim are the lead authors of the study published in the latest is-



Schistura densiclava, a new species of troglophile loach, was found in East Khasi Hills district. SPECIAL ARRANGEMENT

sue of the *Journal of Fish Biology*. The other authors are Hrishikesh Choudhury, Rajdeep Das, Rejani Chandran, Rajeev K. Singh, Deisakee P. Warbah, Wandalin Lyngdoh, Uttam Kumar Sarkar, and Dandadhar Sarma.

The newly described loach, a bottom-dwelling fish with barbels hanging

from the mouth, was found in a cool, fast-flowing stream about 60 metres inside the cave, where the temperature was 18 degrees Celsius and oxygen levels were low.

Belonging to the Nemacheilidae family, *Schistura densiclava* is adapted to the dark, subterranean environment but can also

survive in surface waters. According to the authors, it retains pigment and eyesight, unlike other cave-dwelling fishes.

The newly described loach has a pale yellow-green body "marked with 14-20 greyish black to faint black bars" and a thick stripe near the dorsal fin. This stripe gave the loach its name - *densiclava*, which means "thick stripe" in Latin.

The study said the *Schistura densiclava* males are slimmer with irregular patterns and puffer cheeks, while the females are sturdier with consistent markings.

"Genetic testing confirmed it as a completely new species... The distribution of the new species is limited to the cave, which suggests endemism in this cave system," the researchers said.





Government to unveil Bharat Forecasting System today

The government will on Monday unveil a new “Bharat Forecasting System” (BFS) that will enable the weather office to provide more accurate and localised predictions. Developed by the Pune-based Indian Institute of Tropical Meteorology, it will provide forecasts with a 6 km resolution – the highest in the world – that would allow forecasters to predict small-scale weather features accurately. “We will now be able to issue more localised and accurate weather forecasts,” M. Ravichandran, Secretary, Ministry of Earth Sciences, said. The new forecasting model was made possible due to installation of the new supercomputer Arka at the IITM campus last year. PTI



Operation Sindoor is face of transforming India: Modi

Modi credits home-grown defence capabilities for mission's success while praising the precision strikes by the Indian armed forces on terror infrastructure in Pakistan and PoJK on 'Mann Ki Baat'

The Hindu Bureau
NEW DELHI

Prime Minister Narendra Modi, in the latest episode of his monthly radio programme *Mann Ki Baat*, on Sunday, said that Operation Sindoor was not just a military mission but also the “face of a changing India”.

While lauding the “precision and accuracy” with which Indian forces attacked terrorist infrastructure across the border, he commended the “Made in India” weapons, equipment and technology that contributed to the victory.

Operation Sindoor was launched on the intervening night of May 6-7 in the wake of the April 22 Pahalgam terrorist attack. The Indian armed forces struck at nine sites in Pakistan and Pakistan-occupied Jammu and Kashmir (PoJK), destroying known terrorist bases, including the headquarters of the Lashkar-e-Taiba, the Jaish-e-Muhammad, and the Hizbul Mujahideen.

In accompanying visuals on YouTube, Mr. Modi showed pictures of ter-

ror sites destroyed by the Indian armed forces in Pakistan and PoJK.

“Operation Sindoor is not just a military mission; it is a picture of our resolve, courage, and a transforming India, and this picture has infused the whole country with a sense of patriotism, and has painted it in the hues of the Tricolour,” Mr. Modi said.

He credited India's home-grown defence capabilities for the mission's success following the spirit

of “Aatmanirbhar Bharat”. “This was the ultimate bravery of our soldiers, backed by the power of weapons, equipment and technology made in India,” Mr. Modi said.

The Prime Minister made a fresh pitch for “vocal for local”, urging people to buy “Made in India” goods, to travel within India for vacations, to gift Indian handicrafts, and so on. “Let us take a pledge on this occasion – wherever possible in our lives, we

will accord priority to products made in the country. This is not just a matter of economic self-reliance... it is a feeling of participation in nation-building. One step of ours can become a huge contribution to the progress of India,” he said.

Operation Sindoor's success was celebrated across the country in many ways, ranging from patriotic poems on social media to paintings by children and massive ‘Tiranga Yatras’, he said.



Talk to the nation: Senior BJP leaders listening to Prime Minister Narendra Modi's radio programme, in New Delhi on Sunday. PTI

India, Maldives to review economic and maritime security partnership

Press Trust of India

NEW DELHI

External Affairs Minister S. Jaishankar and his Maldivian counterpart Abdulla Khaleel will on Monday take stock of the implementation of the India-Maldives comprehensive economic and maritime security partnership.

Mr. Khaleel, accompanied by a high-level delegation, arrived in Delhi this evening on a three-day visit. It is his third trip to India this year.

The India-Maldives vision document on comprehensive economic and maritime security partnership was adopted by Prime Minister Narendra Modi and Maldivian President Mohamed Muizzu in October last year.

Foreign Minister Khaleel's visit is in continuation of "intensified high-level political exchanges" between India and Maldives, the Ministry of External Affairs (MEA) said announcing his trip.



The Maldivian delegation led by Foreign Minister Abdulla Khaleel, left, being welcomed upon arrival in New Delhi on Sunday. ANI

It said Mr. Khaleel will lead Maldives at the second High Level Core Group (HLCG) meeting to oversee progress in the implementation of the India-Maldives vision document on comprehensive economic and maritime security partnership. Foreign Minister Khaleel will also hold bilateral discussions with External Affairs Minister S. Jaishankar, it said.

"Maldives is India's key maritime neighbour and an important partner in India's 'Neighbourhood First' policy and vision MAHASAGAR that is Mutual

and Holistic Advancement for Security and Growth Across Regions," the MEA said in a statement.

The ties between India and the Maldives came under severe strain after Mr. Muizzu, known for his pro-China leanings, took charge of the top office in November 2023. Within hours of his oath, he had demanded the withdrawal of Indian military personnel from his country.

There was a thaw in the relations as Mr. Muizzu vowed to boost the bilateral ties with India during his visit to Delhi in October.

DMK's youth wing flays ASI for seeking revision of report on Keezhadi digs

The Hindu Bureau
TIRUCHI

Condemning the Archaeological Survey of India (ASI) for seeking a revision of the report on the excavations carried out at the ancient site of Keezhadi in Sivaganga district, the Dravida Munnetra Kazhagam's (DMK) youth wing on Sunday claimed that the Union government was trying to downplay the history of Tamil Nadu.

A resolution with this regard was passed during the State-level meeting of the DMK's youth wing, which was chaired by Deputy Chief Minister Udhayanidhi Stalin.

As per the resolution, archaeologist Amarnath Ramakrishna, in a report he submitted in January



The resolution was passed at a meeting of the DMK's youth wing chaired by Deputy Chief Minister Udhayanidhi Stalin. G. MOORTHY

2023, had conclusively established that the ancient civilisation of the Tamils dated back to 2,200 years.

However, the ASI delayed the publication of the

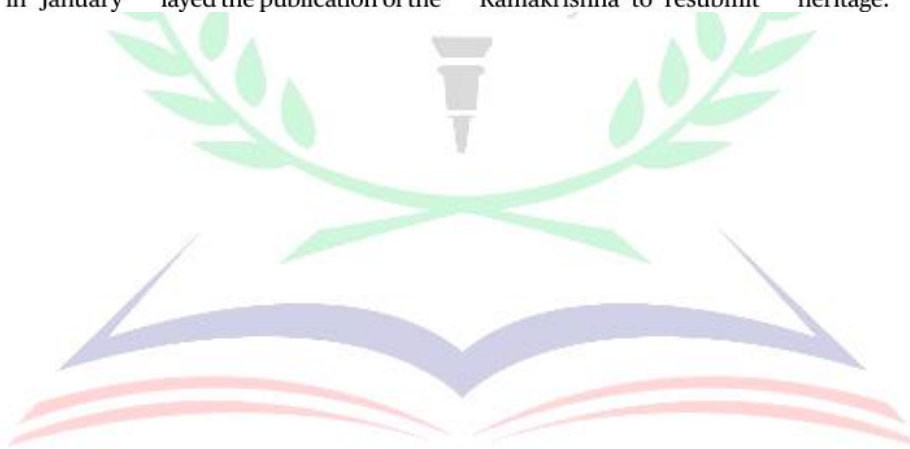
report. When the issue was raised in the Parliament, it was said that the report would be released soon. The ASI has now asked Mr. Ramakrishna to resubmit

the report by making corrections, the resolution noted.

This is condemnable, and it shows that the Bharatiya Janata Party (BJP) government was unwilling to accept the fact that the urban civilisation of the Tamils dated back to 2,200 years, the resolution said.

'Based on evidence'

Meanwhile, Viduthalai Chiruthaigal Katchi leader and Member of Parliament Thol. Thirumavalavan said that the report on the excavations at Keezhadi was grounded in scientific evidence, and that those demanding revisions to the report without substantiating their claims were either ignorant or harbouring hostility towards Tamil heritage.



Caste count a means to include those left behind: PM

The Hindu Bureau
NEW DELHI

Prime Minister Narendra Modi on Sunday said the caste enumeration announced as part of the decennial Census was a step towards his government's model of bringing the marginalised and those left behind in every field into the mainstream of development.

Addressing a conclave of Chief Ministers and Deputy Chief Ministers belonging to the National Democratic Alliance (NDA), Mr. Modi said the success of Operation Sindoor was a reaffirmation of the achievements the country had made in its push towards self-reliance, underscoring the accuracy and precision of indigenous defence technology.

Sources present at the meeting said Mr. Modi



Big meeting: Prime Minister Narendra Modi with Bihar CM Nitish Kumar during an NDA conclave in New Delhi on Sunday. PTI

asked leaders to avoid the tendency to speak out of turn, a likely reference to more than one Bharatiya Janata Party leader making contentious remarks about the Pahalgam terror attack and Operation Sindoor.

The conclave is a regular event held over the years, where Chief Ministers make presentations of best practices being fol-

lowed by their govern-

ments for replication in other NDA-ruled States. Two resolutions were passed at the meeting – one praising the Indian armed forces and the leadership of the Prime Minister over Operation Sindoor and another on the decision to undertake a caste census by the Modi government.

The resolution on Operation Sindoor was moved

by Rajasthan Chief Minister Bhajan Lal Sharma and seconded by Maharashtra Deputy Chief Minister Eknath Shinde, while the resolution on caste census was moved by Haryana Chief Minister Nayab Singh Saini and seconded by Andhra Pradesh Deputy Chief Minister Pawan Kalyan.

Speaking on the occasion, Mr. Shinde, who is also the leader of BJP ally Shiv Sena, said, "The world needs to hear India's resolve (through Operation Sindoor) loud and clear – whoever dares to provoke India will be wiped out. The strength of our defence forces is the impenetrable shield protecting the nation."

Briefing media after the meeting, BJP president J.P. Nadda said that through the resolution on the caste census, it was being clari-

fied that the NDA "does not believe in caste politics but caste enumeration will help those left behind in different fields to develop".

"Enumerating caste was always part of our political imagination and it was an NDA government, under [Bihar] Chief Minister Nitish Kumar, which had proposed to do this first," Mr. Nadda said.

The third Narendra Modi government will be completing a year on June 4, with the NDA completing 11 years in power with Mr. Modi at the helm, which will be marked on June 9.

"We will on June 25 also be marking the 50th anniversary of the imposition of Emergency in India, and will on this occasion again see who worked to suspend democratic rights in the country and who defended these values," Mr. Nadda said.

