May 2022

IN SEARCH OF EXCELLENCE

Newsletter of Regional Training Institute, Chennai

Director General's Message

BY SANKARAN RAJANI, IA&AS

Regional Training Institute, Chennai is extremely happy to bring out the 2022 issue of the in-house newsletter 'In search of Excellence'.

"The secret of change is to focus all of your energy, not on fighting the old, but on building the new" ~ Socrates

True to the words of Socrates, we, at Regional Training Institute, Chennai, did not let the covid pandemic put our training progammes on hold. We adapted our methods and delivery to meet the new challenges and even forayed into developing digital self-learning packages. Thanks to these endeavours, our training performance was quite ahead of the initial targets and we could add substantially to the repository of training materials in our knowledge centre topics.

We are happy to present a brief of the aforesaid in this issue besides a few articles by the officials working here at Regional Training Institute, Chennai

Please feel free to send your suggestions and comments on the newsletter.

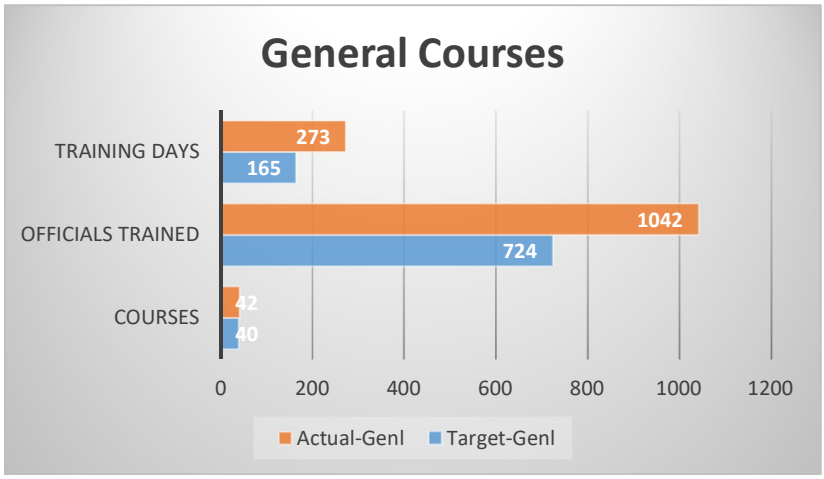
This Issue:

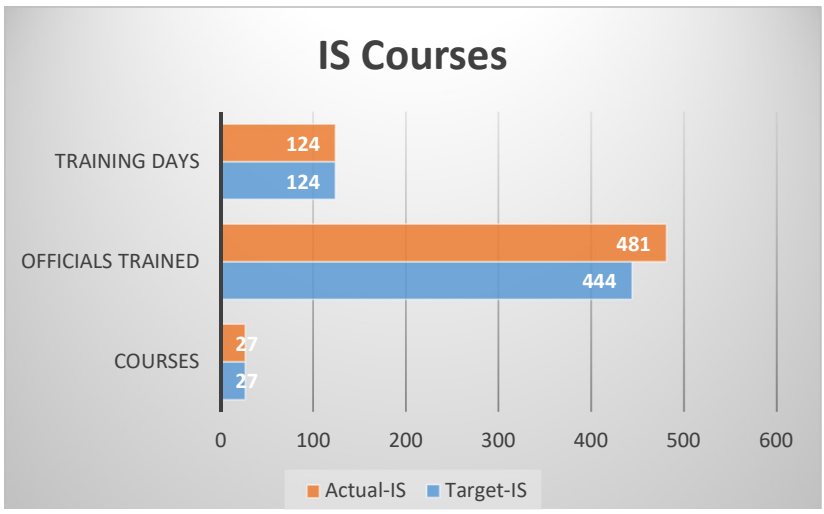
Achievements

Regional Training Institute, Chennai functions with the mission of enhancing and refining the skills of its user offices.

In spite of lockdown and movement restrictions during the second phase of the Covid-19 pandemic, we conducted all the scheduled courses in on-line mode. We also conducted additional courses and have outperformed the targets fixed for the year 2021-22, in terms of number of courses held as well as participants trained. A synopsis is given below:

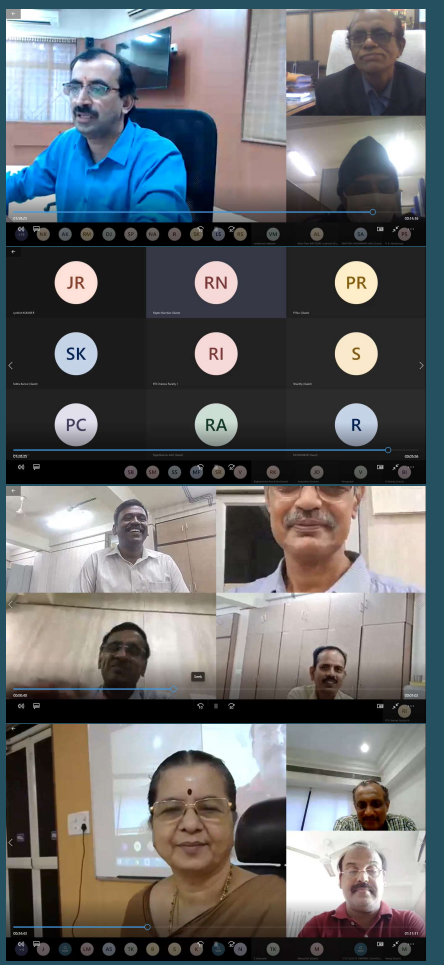
	Target-Genl	Actual-Genl	Target-IS	Actual-IS
Courses	40	42	27	27
Officials trained	724	1042	444	481
Training Days	165	273	124	124





Water will flow from a well in the sand in proportion to the depth to which it is dug, and knowledge will flow from a man in proportion to his learning

- Thirukural 396 -



(Few stills from Online Courses)

Besides the above training courses, we prepared Structured Training Modules and Case Studies for various courses, as detailed below:

Structured Training Modules

Sl#	Particulars of Structured Training Module
1	Data Analytics using R
2	State Finances Audit Report
3	Mid-Career Training Programme (Level 3) *(in coordination with RTI Hyderabad)*
4	Data Analytics using Postgre SQL *(pending approval)*

Case Studies

Sl#	Particulars of Case Studies
1	Vitiation in Works Contracts
2	Place of Supply (GST)

Journey of developing e-Learning Module

In keeping pace with various e-Governance initiatives of the Union Government and the paradigm shift in maintenance of accounts and other documentation from manual to electronic mode, IAAD adopted a number of centralized software applications as also internal application software such as One IAAD One System (OIOS), e-Office, Public Financial Management System (PFMS), Integrated Budget and Expenditure Monitoring System (iBEMS), Smart Performance Appraisal Report Recording Online Window (SPARROW).

In order to train officers/officials of this department in these software and equip them with functional IT knowledge, the Training Wing in HQ introduced the concept of Self Learning Modules [in audio-visual format]. As a part of this initiative, Regional Training Institute, Chennai was selected to develop the Self-Learning Modules on PFMS and iBEMS (Nov 2021).

Preparation of the e-learning modules required IT knowledge as well as functional knowledge of the software. Accordingly, faculty members (IS) having the technical expertise, in coordination with Administrative Wing of this Institute having the day-to-day functional knowledge, set out on the mammoth task of preparation of the Self Learning Modules of around five hours duration divided into six parts.

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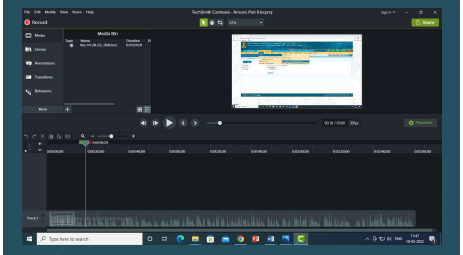
To discern the truth in everything, by whomsoever spoken, is wisdom

- Thirukural 423 -



(Few photographs taken during preparation of e-Learning Modules)

Easier said than done, preparation of the modules required not only technical expertise and functional knowledge but also immense patience, control over voice modulation by the presentor, coordination between audio and visuals and a lot of editing skills. Professional help was hired for the editing part, but the in-house team spent long hours in office for more than two months continuously to achieve, what looked formidable in the beginning.

Mid-Career Training Programme

After a long hiatus of almost two years, the first off-line course on Mid-Career Training Programme was conducted in the month of March 2022.

The classroom training after the long gap was received very well by the participants. Sharing of experiences and transfer of knowledge without the barrier of technology was indeed effective and enjoyable. The faculty members were delighted to re-invent themselves in their old form.

A half day field trip was organized for the participants at 'Kalakshetra Foundation', a centre for artistic endeavour. Founded in 1936 by the vibrant visionary Rukmini Devi Arundale, the Institution stands testimony to her dream of creating a space where the essence of Indian thought would find expression through artistic education. Spread over an area of 40 hectares, one can forget the stressful day-to-day life and immerse in the aesthetics of art and culture and the ambient surroundings.

The participants appreciated the idea of field trip and also enjoyed the trip as this was the first outing for many of them after the pandemic.

On the very next day, they made four group presentations on the field trip in the presence of Director General. The presentations made by each of the groups was really excellent from the point of view of materiality as well as the delivery aspect. What was more interesting is that each of the presentations was totally different from the other, although on the same subject. This made us realise the importance of soft skills such as group dynamics, communication skills, etc., which were part of the course structure.

Let a man learn thoroughly whatever he may learn, and let his conduct be worthy of his learning

- Thirukural 391 -

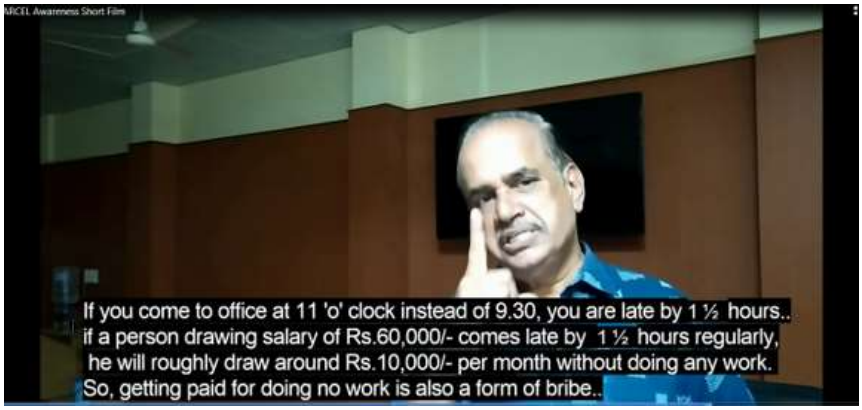
(Few photographs of Field Visit during MCTP Course and group presentation)

Short Play on Soft Skills – A new initiative

In order to break the monotony of classroom sessions and to disseminate messages on soft skills in a convincing and interesting manner, we have embarked on a journey of producing short plays using our in-house talent.

These short plays are intended to be played in a classroom environment, when a session on a related subject is in progress. These could even be played during short breaks, to drive home the message.

As a first step in this direction, we produced a short play on 'punctuality' written and directed by Shri K Saravanan, Assistant Supervisor of this Institute. This is a complete in-house production with staff/outsourced persons from this Institute and user offices acting in the play. This was played during the session on 'Personal and Professional Ethics and Code of Ethics' in the Mid-Career Training Programme held in March 2022 and was very well received by the participants. The short play in Tamil with English sub-titles, has been forwarded to HQ for dissemination amongst other offices of IAAD.



There is no wealth like knowledge, and no poverty like ignorance

- Buddha -

(Few stills from the Short Play)

Article by Staff Members

Musings of a Maverick

By A Raju, Ex-Faculty Member (Civil)

The major discussion in the media today in the aftermath of heavy rains in southern parts of the country is that a lot of water has been released into the rivers due to the filling up of the reservoirs and leading to huge quantities of water going waste into the sea. The various media write or speak or discuss about the poor water management systems/processes and lack of preparedness to store the excess water for effective use till the next monsoon.

But, is this what Mother Nature wants !!!

Is not Mother Nature duty bound to take care of the entire Planet by providing for every species - who are her children !!!

It is nature's design that the water that evaporates from the oceans come back as rains and replenishes the oceans so that the density of the salts in the oceans are maintained to take care of the marine ecology and at the same time providing water, the elixir of life, for those species on land. If no rain water is allowed to go back to the oceans, is it not against nature's design !!!

Today, anything that happens to any eco-system, man is blamed? Yes, may be, it is true. But, where are the dinosaurs and the other life forms of the ancient era !!! They never lived alongside humans, but had become extinct even before man set foot on the planet!!! They had become extinct not because of human intervention, but nature makes some adjustments through which she sacrifices a few to save the rest !!!

Probably, Mother Nature wanted the Oceanic Biosphere to maintain its density and ensured that over and above what man wanted to capture the resources which are destined to be that of the oceans, she ensures that they reach the oceans. The scientific world may argue that the storage capacities of the reservoirs may be increased. Yes, this may be done, but the maximum storage is again limited not by the borders of the engineering skills of man, but by the geological restrictions placed by Mother Nature.

It's true that we are inching towards the great deluge, which is inevitable, but if we are to tinker with the delicate balance of Mother Nature, it will not be long before we start hurtling towards the great deluge !!!.

In vain have you acquired knowledge if you have not imparted it to others

- Deuteronomy Rabbah -

(Garden at RTI, Chennai)

Tubelight

By A Raju, Ex-Faculty Member (Civil)

There are only ten numerals, viz. 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9. The face value of these numerals is fixed but the value of the numbers formed with these numerals depends on the place value of these in forming the numbers with reference to the position of each one of them, like ones, tens, hundreds and so on.

Similarly, every human being is born with a face value and it remains fixed throughout his life. But, the way the society values him is not on his face value, but the effect of face value with reference to how he places himself in the society, viz. Place value.

A numeral which is assigned a particular value – say '1', cannot change its face value, but can get itself a higher value by virtue of its position in the tenth, hundredth, etc. position in an overall number. Similarly, a particular person endowed with a specific skill/talent, which may get the due recognition, can place himself in a position in the society where that specific skill/talent gets recognised better.

This is corroborated by the fact that many persons who may boast of academic excellence are not always successful in life, whereas those with mediocre or poor academic achievements reach greater heights in the ladder of success. In the case of the former, it is high face value with a poor place value and in the latter, it is small face value positioned in a higher place value.

So do not worry if you are born a 'tube light'; just associate yourself with an electronic choke and the whole world would look up to you for brightness !!!

Share your knowledge. It's a way to achieve immortality

- Dalai Lama -

(Hindi Divas celebrations at RTI, Chennai)

Artificial Intelligence in Audit – A Concept Paper

By Deepak Viswanathan, Ex-FM (IS)

Introduction

Artificial intelligence (AI) is the ability of a digital computer to perform tasks commonly associated with intelligent beings. The term is frequently applied to the project of developing systems endowed with the intellectual processes characteristic of humans, such as the ability to reason, discover meaning, generalize, or learn from past experience. AI includes in its fold a number of related applications such as data analytics, data mining, machine learning, Natural Language Processing (NLP) and analysis of unstructured information as in social media communications to detect popular sentiment.

Application of AI based tools in audit is becoming increasingly relevant to Supreme Audit Institutions (SAIs) in performing their mandate in a digitally transformed world. Governance is becoming increasingly data driven. Further, emails, social media messages, audio and videos files and digitized documents hold a lot of information relevant to an auditor to plan and execute his work. Analysis of such unstructured data is possible only through the employment of tools that combine technologies such as NLP along with traditional predictive algorithms. AI comes to the aid of the auditor in

1. Automating repetitive and routine tasks
2. Performing comprehensive audits without recourse to sampling, to provide better audit assurance
3. Detecting unusual patterns and outliers within the data
4. Predicting potential risks at a measurable level of accuracy

A recent paper by the World Bank group reports that a number of SAIs have invested in the development, implementation, and use of highly sophisticated IT-based audit tools and procedures. Possible applications of AI in public audit and the challenges that need to be overcome to harness the full potential of the technology is briefly presented.

Specific applications of AI in Audit

As discussed, AI algorithms help auditors to review the entire population of data rather than a representative sample. These algorithms are trained primarily to detect anomalies, which help auditors to focus their efforts on issues that are relevant and material. In addition, AI algorithms dynamically learn and become more refined over time, thus improving audit efficiency and effectiveness. AI is currently being applied in a host of audit processes like contract review, fraud detection and sentiment analysis.

Fraud detection

In financial auditing, AI programs can be developed which test every journal entry and detect anomalous patterns such as an unusually high number of journal entry postings just under authorized limits. The programs can also detect common anomalies such as entries from unauthorized sources, and search for entry descriptions containing suspicious expressions. A possible strategy for fraud detection will be to train the algorithm with a set of pre-classified data where the fraud/non-fraud transactions are labelled. The algorithm learns the combined effect of multiple attribute values for each type and develops a model which can be directly applied to untested data. Through many iterations, the algorithm can be refined to an acceptable level of reliability.

Contract review

Contract review requires auditors to read hundreds of contract documents, each running into several pages and interpret provisions expressed in complex legal terms. Machine learning tools allow humans to analyze a larger number of contracts, such as leases, derivatives contracts, agreements and sales contracts, in a much shorter timeframe than is possible with a traditional manual review. This requires application of technologies such as NLP in combination with traditional classification algorithms. AI tools can be programmed to identify key contract terms, as well as trends and outliers and extract information using pre-selected criteria at a higher level of precision than is possible by a human reviewer. For example, identifying key contract terms will help auditors to accurately identify the type of contract and select only the relevant types for detailed manual review. Non-standard leases with unusual terms can be identified and selected for additional consideration. Thus, AI allows auditors to focus specifically on the contracts with the highest inherent risk, which would improve both the speed and quality of the audit.

Sentiment analysis

Sentiment analysis (or opinion mining) is a technique involving the application of NLP to determine whether a given set of unstructured data expresse a generally positive, negative or neutral sentiment. This can be applied on emails, social media posts, reviews, articles, blog posts as also on multimedia files. Sentiment analysis enables the auditor to scan through voluminous text and extract key terms and popular opinion associated with them. A potential application of this maybe in identifying issues of contemporary relevance, so that subjects selected for audit are topical and significant.

Challenges

Though the advantages of using AI tools in auditing is well understood and established, there are a number of challenges for auditors that must be addressed for these to reach their full capabilities. The challenges related to AI may be direct or indirect. Direct challenges are related to concerns of data privacy, confidentiality, quality and explainability of the results of audit. Indirect challenges are related to ethical concerns such as auditor competence and the avoidance of bias.

Data Privacy and quality

The effective use of AI often requires access to large amounts of data from varied sources and in different formats. Some of this data will be of a confidential nature. In this scenario, SAIs need to assess the risks associated with loss of confidentiality and implement strict security mechanisms commensurate with the sensitivity of the data.

The quality of analysis also depends on the quality of the underlying data. Analysis performed on erroneous data may result in incorrect learning by the AI algorithms and deliver unreliable output. Therefore, it is essential that a preliminary analysis to ensure the quality of data is undertaken prior to using such data in AI processes particularly during the training stage.

Skill and Infrastructure

To be able to use AI in auditing, auditors need to develop a solid understanding of information systems and data science to understand the underlying logic, possible biases and other limitations that may affect the results of the analysis. Building this skillset requires that SAIs adopt a comprehensive capacity development program that allows for specialization, progressive skill development, application and continued education. Since AI tools are applied typically on large and quickly growing volumes of data, as also involve both structured and unstructured data, storage and retrieval pose significant challenges. SAIs will require to adopt big data approaches to address this challenge, involving such technologies as Hadoop that will enable secure storage, fast processing and the ability to deal with semi-structured or even unstructured data.

Auditing standards

Because of the transformative effect AI has on auditing, it becomes necessary that new auditing standards need to be formulated and traditional standards appropriately modified to address the specifics of audit planning, execution, documentation and reporting through AI. For example, in addition to documenting the procedures, sampling techniques etc., auditors will need to document the nature of test data, justify the choice of predictive algorithms, the results of model refinement as also their evaluation and validation of results. Such standards should also address concerns of data privacy, and, fair and transparent processing.

Reliability of AI Algorithms

Complex AI tools use multiple algorithms to recognize relationships between large volumes of data. The output of such analysis resulting from the complex interactions between these algorithms makes it difficult to explain, justify or document the results. This lack of transparency or explainability of sophisticated AI tools is commonly referred to as the 'black box problem'. Hence auditors also need to consider controls and processes around their AI audit tool. In preparing appropriate documentation when AI has been applied in performing the audit, it is important for auditors to be able to explain why the AI tool has selected "unusual" or "anomalous" transactions.

Another factor affecting the reliability of AI tools is the role played by human bias in the development of the analytic model. Such biases can affect which data sets are chosen for training the AI, the methods chosen for the process, and the interpretation of the output. For example, auditors may use most easily accessible information to identify risks or form conclusions. Another source of bias is 'overweighting' or using only input data that supports preexisting beliefs. Failure to validate machine outcomes will also compromise the reliability of AI.

Conclusion

Though AI can bring significant advantages to the auditing profession, it is to be remembered that results from AI are probabilistic predictions based on inferences in the correlation of data and should not be taken as truths. Auditors are required to exercise their judgements and apply their own insights to interpret the context underlying the analytical results and should be mindful of the inherent deficiencies both in the input data as well as program logic before reaching audit conclusions

References

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Virtual Currencies and security issues

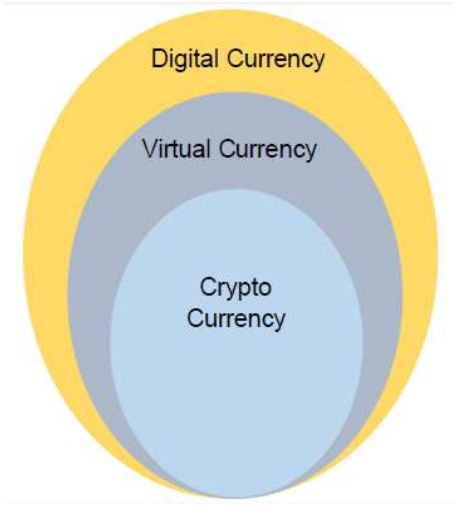
By J Shankar Ram, Faculty Member (IS)

Hon'ble Finance Minister Nirmala Sitharaman, during her Budget in Feb 2022, said "The introduction of central bank digital currency (CBDC) will give a big boost to the digital economy. Digital currency will also be a more cheaper and efficient currency management system," She also underlined: "It is therefore proposed to introduce digital rupee - using blockchain and other technologies - to be issued by the Reserve Bank of India, starting 2022-23." Experts say that with CBDC using blockchain technology, all transactions can be tracked on the ledger with no ability to modify the past – leading to transparency.

The move is seen as a big push for the government's "Digital India" programme. Moreover, no country has yet implemented a CBDC-based economy though many are in the testing phase currently. "India will now join a handful of nations to launch its own blockchain currency. The issuance of a central bank digital currency (CBDC) will enable an efficient transfer of digital rupee much like UPI, IMPS or NEFT.

Amid deliberation over the regulation of cryptocurrency, the Reserve Bank of India (RBI) had voiced "serious concerns" around private cryptocurrencies on the grounds that these can cause financial instability.

Digital, Virtual, and Crypto Currencies:



Digital currency covers a wide group representing monetary assets in digital form. Digital currency is the overall superset that includes virtual currency and cryptocurrencies. A Digital currency may be regulated or unregulated and can be denominated to a sovereign currency. Digital currencies can be issued by a country's central bank as flat currency notes

Virtual currency is a type of unregulated, digital money which is issued and controlled by its developers that are accepted and used among the members of a specific virtual community.

Cryptocurrencies are those which use secured cryptographic techniques for authentic transactions, and for managing and controlling the creation of new currency units. Bitcoin and Ethereum are examples of Cryptocurrencies. These are prone to fluctuations in their monetary value due to the lack of a centralized regulatory authority. The value is derived based on certain mechanisms such as mining in Cryptocurrencies or the backing by the underlying asset and are traded in the crypto exchanges.

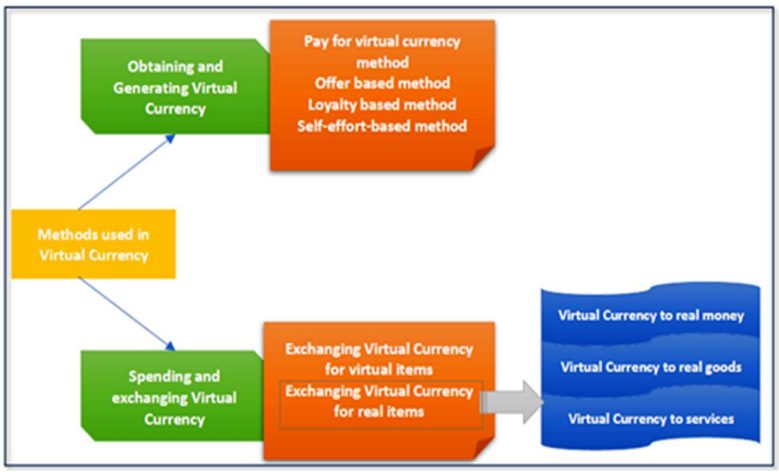
- There are 18,465 total cryptocurrencies
- The total market cap of all cryptocurrencies is $2.023 trillion
- The trading volume of all cryptocurrencies per 24 hours is currently $75 billion
- Bitcoin has the highest current market cap at over $700 billion - more than double its closest rival Etherum
- four of the top 20 cryptocurrencies are directly pegged to USD value - Tether, USD Coin, Binance USD, Terra USD.
- Approximately 8% of the US population trades cryptocurrency
- As a continent, Asia has over 4x more cryptocurrency users than any other continent

The most popular crypto currency BITCOIN was introduced in 2008 by an unknown person or group of people using the name Satoshi Nakamoto. The currency began use in 2009 when its implementation was released as open-source software.

Bitcoins are created as a reward for a process known as mining. They can be exchanged for other currencies, products, and services. Bitcoin has been criticized for its use in illegal transactions, the large amount of electricity (and thus carbon footprint) used by mining, price volatility, and thefts from exchanges. Some investors and economists have characterized it as a speculative bubble at various times. Others have used it as an investment, although several regulatory agencies have issued investor alerts about bitcoin. However, a few local and national governments are officially using Bitcoin in some capacity, with one country, El Salvador, adopting it as a legal tender.

Obtaining and Generating Virtual Currency

Since there is no universal virtual currency across the digital medium, there are several different ways and methods to obtain or generate the virtual currencies.

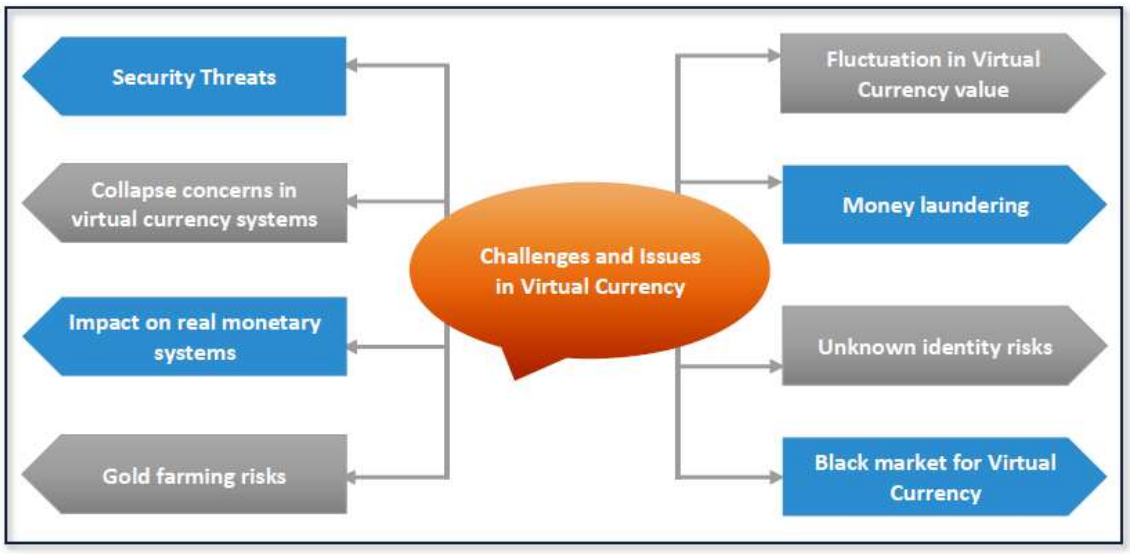


Security issues in Virtual Currency

Virtual currencies often face many issues and challenges with respect to security in financial concerns.

(i) Security threats:

Knowing the process of creating and generating virtual currencies, hackers and other illegal users can easily break into user systems. Hackers modify genuine user accounts to steal virtual currencies. They also create fake virtual currencies to defraud the legitimate users. For example, selling in-game virtual items and virtual currency are against World of Warcraft (WoW) game policies. To earn virtual gold by exchanging virtual currencies for what they need, users log into this WoW gold selling websites. Most of these websites are prone to security issues and vulnerable to threats where users complain about exchanging virtual currencies for real money.



(ii) **Impact on real monetary systems**

The demands and supply of the real monetary systems get affected due to several virtual currency system platforms. Virtual money can be used for purchasing instead of real money. Some virtual currency platforms allow users in exchanging virtual currencies for real money increasing the demand. This fluctuation affects the real monetary systems

(iii) **Collapse concerns in Virtual Currency Systems**

These problems arise in communities and organizations when the issue of virtual currencies is not dependent on the demand and supply of goods and products. On one occasion unlimited issue of Linden Dollars were carried out for the purpose of gaining larger real revenues for virtual items, which led to its collapse.

(iv) Gold farming risks

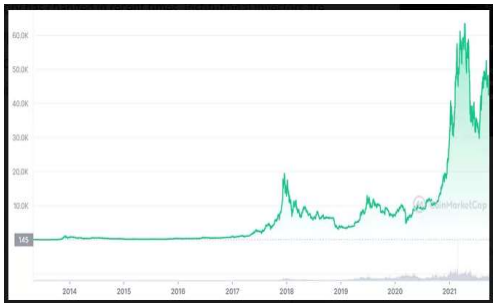
Gold farming is prominent in China and other developing countries. Here the gamers play games like WoW for earning gold as virtual currency which can then be exchanged with real monetary system.

(v) Fluctuation in virtual currency value

The value of virtual currency is devalued with the decrease in the popularity of the virtual community. For instance, users owning 1000 units of virtual currency can usually buy 100 different items. If there is a downfall in the virtual currency, then the purchase of 100 items also downfalls to 10 items. This normally takes place in closed virtual communities.

(Fluctuation in span of 2 years)

Date	Value of 1 Bit Coin
13 March 2020	$3,800
18 November 2020	$ 18,000
1 June 1 2021	$ 37,265
7 November 2021	$67,549
26 April 2022	$ 38,027



(From 2014 to 2022)

(vi) Money laundering

During exchange of virtual currency with real money, there arises an issue of money laundering since virtual currencies can be laundered during exchanges. For example, money laundering case that happened in Korea during 2008 where criminals were arrested for selling virtual currency by converting $38 million. The money was generated through gold farming methods as an exchange of currency.

(vii) Unknown identity risks

Most of the financial online transactions become unmonitored due to unauthorized accounts created in social media and gaming. Many unknown identities are created during illegal transactions as users create and use more than one account with real as well as unreal details. This paves way to identify the creation and transaction of virtual currencies source. In addition, the tracking of money laundering or suspicious transactions becomes difficult. Due to the unknown identities, criminals have an easy way to pay for their illegal activities with virtual currencies.

(viii) Black market for virtual currency

The black markets are usually created with the activity of buying and selling virtual currencies mostly in social games. The increase in the popularity of virtual currency paves to the growing of black markets during trading process.

(x) Security issues in Block Chain

Blockchain model on which the crypto currencies are based, is also subject to various security attacks viz Double-Spending attack, transaction malleability attack, time jacking attack (vulnerability in Bitcoin timestamp handling) and Sybil attack where the reputation of the system is challenged by forging identities

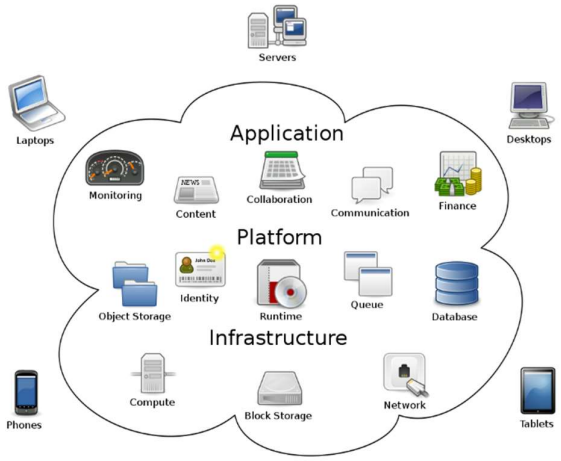
With the increasing use of private virtual currencies in exchange for real money, Reserve Bank of India (RBI) had voiced "serious concerns" on the grounds that these may cause financial instability and there is an urgent need to regulated these virtual currencies

Cloud, Fog and Dew computing

By J Shankar Ram, Faculty Member (IS)

Cloud Computing

US National Institute of Standards and Technology (NIST) defines Computing as: "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."



In cloud computing, the group of networked elements providing services need not be individually addressed or managed by consumer/users; instead, the entire provider-managed suite of hardware and software can be thought of as an amorphous cloud.

In simple terms, cloud computing is about hiring computer resources over the web and paying on metered use basis.

Cloud computing can be availed by a customer in various formats called service models. These service models can be broadly group as:

Software as Service (SaaS): The use of the software is over the web. Eg Google DOCS, Google spread sheet, Google Drive, Onedrive etc.

Infrastructure as a Service (IaaS): The customer avails the facility of virtualized hardware called virtual machines (VM). The customer is relieved of the problem of setting up and maintaining a data centre for his organisation

Platform as a Service (PaaS): The consumer avails the underlying cloud infrastructure including network, servers, operating systems, or storage, but deploys his own deployed dedicated applications and controls the configuration settings for the application-hosting environment.

The main advantages of cloud computing are:

On-demand self-service: A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider.

Broad network access: Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).

Resource pooling: The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand.

Measured Service: Cloud systems automatically control and optimize resource use by leveraging a metering capability at a level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service.

Rapid elasticity: Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.

With advent of cloud computing came the benefit of lower computing cost and this helped MSME to deploy ERP systems and other software systems. However, the main bottleneck in cloud computing is that it requires constant internet connection and does not work well with a low-speed internet connection, such as that found with dial-up services. Unstable and slow internet connections make cloud computing painful at best and often impossible.

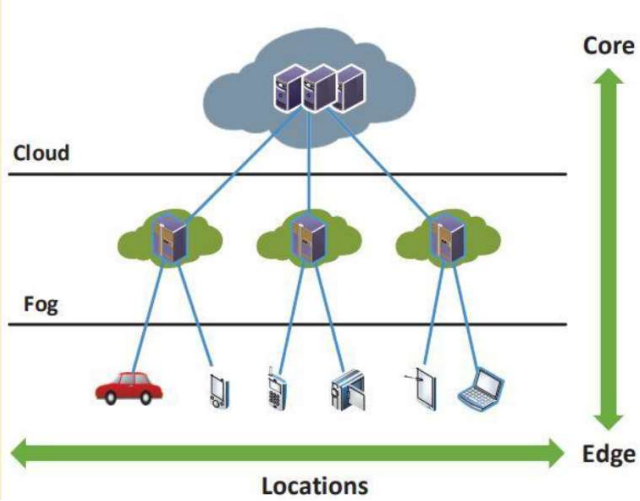
The main issues with Cloud-only computing are:

- Data centres are centralized, so all the data from different regions can cause congestion in core network.
- Communication takes a long time due to several hops and IoT interaction.
- Certain applications task requires very fast response time, eg for driverless car to prevent crashes or traffic jam response needs to be instantaneous.

Fog Computing

The term "Fog Computing" was introduced by the Cisco Systems as new model to ease wireless data transfer to distributed devices in the Internet of Things (IoT) network paradigm

Fog computing, also known as fogging/edge computing, is a model in which data, processing and applications are concentrated in devices at the network edge rather than existing almost entirely in the cloud.



Fog Computing

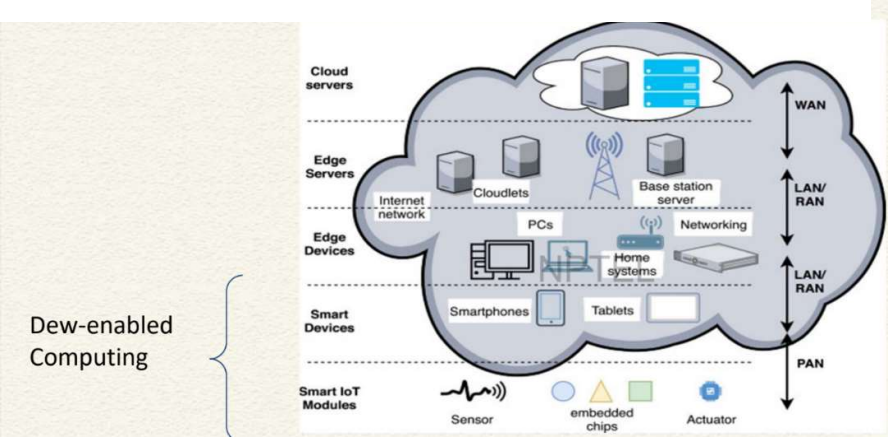
- Brings processing down from the cloud close to the ground/ end-user.
- Cellular base stations, Network routers, WiFi Gateways will be capable of running applications.
- End devices, like sensors, are able to perform basic data processing.
- Processing close to devices lowers response time, enabling real-time applications.

Cloud-Fog computing addresses the issue of latency only. Also, this model can be implemented only in certain applications that can be pushed closer to the client IoT devices.

Dew computing (DC):

Dew computing is an on-device (mobile phones and other IoTs) software-hardware organization paradigm in the cloud computing environment where the device provides functionality that is independent of cloud services and is also collaborative with cloud services. The goal of dew computing is to fully realize the potentials of on-premises computers and cloud services. Dew computing attempts to solve one of the major problems related to cloud computing, such as continuous reliance on internet access.

Dropbox is a typical example of the dew computing paradigm, as it provides access to the files and folders in the cloud in addition to keeping copies on local devices. This allows the user to access files during times without an internet connection; when a connection is established again, files and folders are synchronized back to the cloud server.1



Key features of dew computing are independence and collaboration

- Independence: the local device must be able to provide service without a continuous connection to the Internet.
- Collaboration: the application must be able to connect to the cloud service and synchronize data when appropriate.

The word "dew" reflects natural phenomena: clouds are far from the ground, fog is closer to the ground, and dew is on the ground. Analogically, cloud computing is a remote service, fog computing is beside the user, and dew computing is at the user end.

Thus, in DC - Architecture Dew Server functions to serve user with requested services perform synchronization and correlate between local data and remote data. It attempts to achieve three goals viz Data Replication, Data Distribution and Synchronization.

However, DC architecture can be used only where the application can use the feature of independence and collaboration and not in the case of applications where the cloud database has to have real time updates.

Comparative Analysis

FEATURE	CLOUD	Cloud-FOG-Edge	With DEW
On-premise resource utilization	Low	Sub-optimal	Optimal
Connectivity required	Internet	Local	Local
Uptime	Low	High	High
Bandwidth required	High	Low	Low
Latency	High	Low	Low
Infrastructure requirement	Low	Moderate	Moderate
Processing power	High	Limited	Limited
Data Storage	High	Low	Moderate

The concept of cloud-fog-edge dew computing with emerging 5G networks will enable orchestration of computers and physical systems i.e. cyber-physical system (CPS). CPS will have wide ranging application in assisted living, traffic control and safety, medical devices, automotive systems, manufacturing, military systems, process control, power generation and distribution, energy conservation etc.

[1] WAN : Wide Area Network; LAN : Local Area Network; RAN : Radio Access Network PAN : Personal Area Network

Check your TecQ

By J Shankar Ram, Faculty Member (IS)

1 Who created Bitcoin?
- a) Satoshi Nakamoto
- b) Larry Ellison
- c) John Mcafee
- d) Bill Gates

2) Where do you store your cryptocurrency?
- a) Bank account
- b) Floppy Disk
- c) Wallet
- d) In your pocket

3) What is a blockchain?
- a) A distributed ledger on a peer to peer network
- b) A type of cryptocurrency
- c) An exchange
- d) A centralized ledger

4) Blockchain is the same as Bitcoin?
- a) True
- b) False

5) What is the process of creating new bitcoins popularly known as?
- a) Finding
- b) Panning
- c) Sourcing
- d) Mining

6) Which is NOT a part of asymmetric encryption?
- a) Mining
- b) Public key
- c) Pass phrase
- d) Private Key

7) Disadvantage of the Symmetric key cryptology?
- a) fast
- b) key exchange & management
- c) slow
- d) none of the above

8) Which of the following is a wrong statement about a cryptographic hash function:
- a) given the same message the hash function would return the same hash
- b) it is difficult to generate the original message from the hash
- c) a small change in the message does not impact the hash
- d) it is difficult to find two different messages with same hash

9 Identify the asymmetric encryption algorithm:
- a) Triple Data Encryption Algorithm (TDEA)
- b) MD5
- c) Diffie-Hellman encryption algorithm
- d) None of the above

10) In public key cryptosystem based digital signature, the message digest is signed by:
- a) sender's private key
- b) sender's public key
- c) receiver's private key
- d) receiver's public key

11) In cryptocurrency a ledger records:
- a) list of balances
- b) list of transactions
- c) list of accounts
- d) none of the above

12) What is nonce?
- a) The transaction id number
- b) A miners ASIC chip array
- c) The generator point used in elliptic curve cryptography
- d) The number miners run through to generate a correct hash

13) Which one of the following is not the application to bitcoin script
   a) Escrow Transaction
   b) Micro Payments
   c) Smart Contracts
   d) Green Addresses

14) A bitcoin block contains
   a) Hashes of Transactions
   b) Nonce
   c) Markel Tree Root
   d) Previous Block Hash
   e) All of the above

15) Which of the following is responsible for consensus in hyperledger?
   a) Full Node
   b) Validating Node
   c) Peer Node
   d) Ordering Node

16 Spatial cloud eases out the GIS decision making due to the following reasons:
   a) Integrate the latest databases
   b) Merge disparate systems
   c) Exchange information internally and externally
   d) All of the above

17 The term “Fog Computing” was introduced by:
   a) IBM
   b) Huawei
   c) Cisco
   d) Amazon

18 In Dew Computing, the on-premises computer provides functionality that is dependent of cloud services.
   a) True
   b) False

19 On premise resource utilization is optimum in
   a) Cloud computing
   b) Cloud-Fog-Edge computing
   c) Dew computing
   d) None of the above

20 Smartwatch is an example of
   a) Cloud
   b) Fog node
   c) Edge device
   d) None of the above

Answers:

1 (a) Satoshi Nakamoto	2. (c) Wallet	3 (a) A distributed ledger on a peer to peer network
4 (b) False	5 (d) Mining	6 (a) Mining
7 (b) key exchange & management	8 (c) a small change in the message does not impact the hash	9 (c) Diffie-Hellman encryption algorithm
10 (a) sender's private key	11 (b) list of transactions	12 (d) The number miners run through to generate a correct hash
13 (c) Smart Contracts	14 (e) All of the above	15 (d) Ordering Node
16 (d) All of the above	17 (c) CISCO - The term "Fog Computing" was introduced by Cisco Systems as new model to ease wireless data transfer to distributed devices in the Internet of Things (IoT) network paradigm	
18 (b) FALSE - In Dew Computing, the on-premises computer provides functionality that is independent of cloud services	19 (c) Dew computing	20 (c) Edge device