Innovative Technology Integration for Enhancing LSGI Elections in Kerala

Blockchain & AI for secure, transparent and efficient election management in Kerala

Aromal J R
MA Public Policy student,
St Xaviers College, Mumbai

Need for advanced technologies in elections

Loksabha election voter percentage over the years

Loksabha Election Year	Voting percentage
1951	45.67
1957	47.74
1962	55.42
2009	58.21
2014	66.44
2019	67.40
2024	65.79

1. Voting percentage increasing only at a gradual pace despite;
   - Increased literacy
   - Political awareness
   - Media awareness
   - Information penetration

2. Convenience for voting is a big factor.

3. Technology has the potential to facilitate convenience in elections.

4. Technology can get polling stations coming to people instead of people coming to polling stations.

Emergence of Election Commission

Representation of Peoples Act 1950 & 1951

RPA 1950:

- Allocation of seats in Lok Sabha and State Legislative Assemblies
- Delimitation of constituencies
- Universal Adult Suffrage (right to vote at 18+)
- Qualifications and disqualifications for legislative membership

RPA 1951:

- Detailed election procedures: electoral rolls, nomination, polling, vote counting
- Addressing election malpractices and penalties

Election Commission of India (ECI)

Establishment:

Founded on January 25, 1950, under Article 324 of the Constitution

Role and Responsibilities:

- Supervision, direction, and control of electoral processes
- Management of elections and enforcement of electoral laws

Structure:

- Led by the Chief Election Commissioner, appointed by the President of India
- Independent and autonomous to ensure impartiality

Emergence of State Election Commissions (SECs)

Background:

Need for localized electoral management

Role and Responsibilities:

- Conduct elections for urban and rural local bodies
- Operate autonomously within states

Significance:

- Highlighting democratic decentralization and inclusive representation

73rd and 74th Amendments as Pillars of Decentralization

Overview:

Landmark amendments in 1992 for decentralized governance

Key Committees:

- Balwant Rai Mehta Committee (1957)
- Ashok Mehta Committee (1977)
- G.V.K Rao Committee (1985)
- Sarkaria Commission (1983-1987)
- L.M Singhvi Committee (1986)

Key Provisions of 73rd and 74th Amendments

73rd Amendment:

- Three-tier system of Panchayats
- Establishment of SECs for rural local body elections
- Reservation of seats for marginalized groups

74th Amendment:

- Focus on urban governance through municipalities
- SECs for urban local body elections

Articles:

- Article 243K: Establishment of SECs in States and Union Territories for rural elections
- Article 243Z & 243ZA: SECs for municipal elections

The Roadmap Towards State Election Commission, Kerala

Early Local Body Elections:

- 1953: First local elections under Travancore-Cochin Panchayat Act, 1950
- 1956: Formation of Kerala State
- 1957: Administrative Reforms Committee (ARC) recommends decentralisation. Proposed two-tier system: village panchayats and district councils
- 1960s: Kerala Panchayat/Municipality Acts, elections held in 1963, 1979, 1988

National Influence and Legislative Developments:

- 1992: 73rd and 74th Amendments establish a uniform three-tier system for rural and urban local governance
- Kerala enacts Kerala Panchayat Raj Act 1994 and Kerala Municipality Act 1994
- Local elections held in 1995, 2000, 2005, 2010, 2015, and 2020 under these acts

Establishment of SEC Kerala:

- 1993: Established on December 3 under Articles 243K and 243ZA of the Constitution
- Role: Oversees Panchayat and Municipality elections ensuring fair and regular elections
- Mandate: Articles 243E and 243U ensure five-year election intervals

Significance:

Strengthening democratic processes and promoting decentralised governance in Kerala

TIMELINE SEC KERALA

1

1953
First local elections under the Travancore-Cochin Panchayat Act, 1950

2

1957
ARC recommended decentralization and democratization, suggesting a two-tier system of village panchayats and district councils

3

1960
Panchayat Act divided the Local Bodies Department into Panchayat and Municipal Departments for administrative ease.

4

1992
73rd and 74th amendments passed, establishing rural (PRIs) and urban (Nagarpalikas) local governments, effective from 1993.
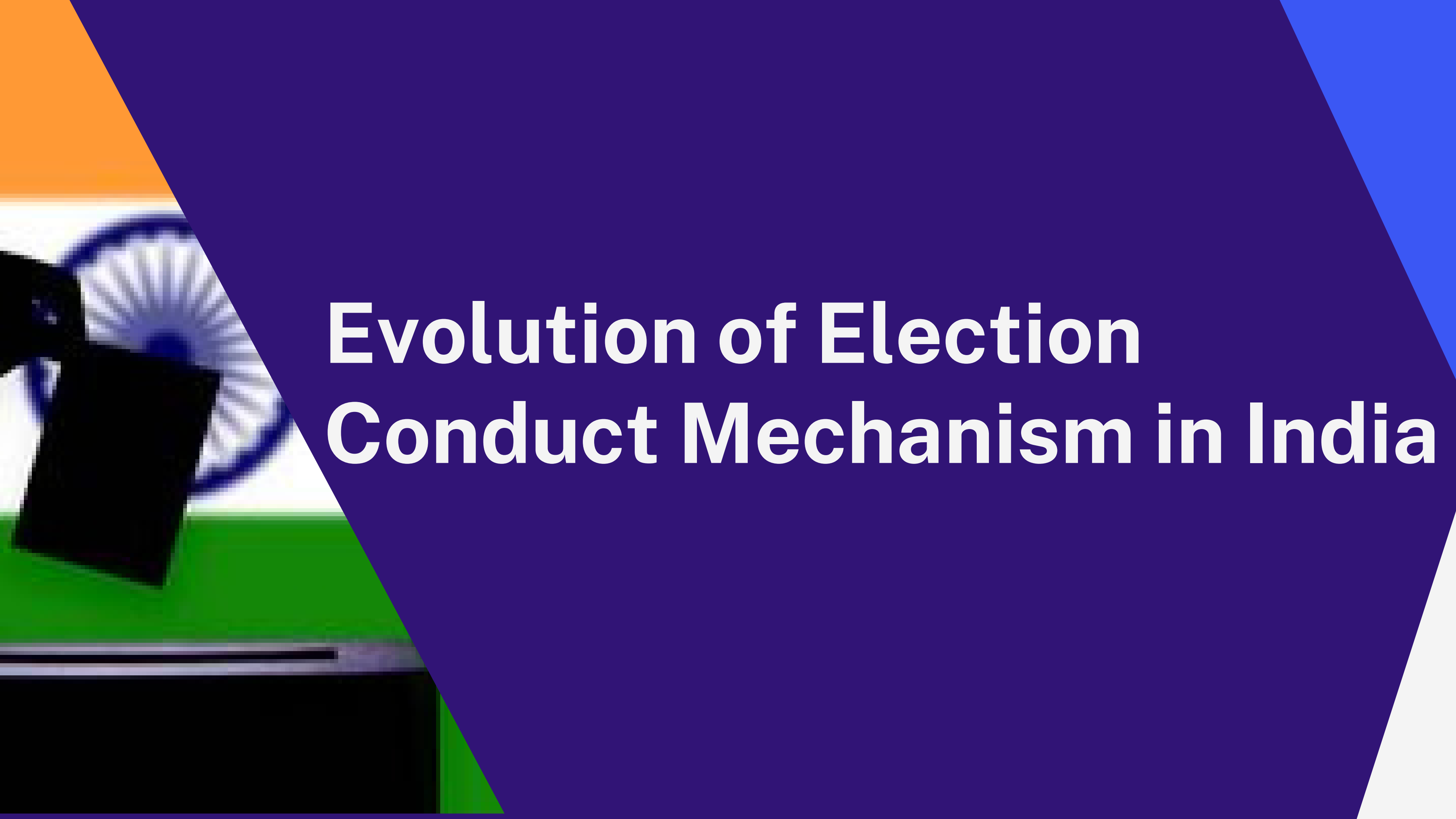
5

1994
Kerala enacted The Kerala Panchayat Raj Act and The Kerala Municipality Act in accordance with the 73rd and 74th amendments.

6

1995
The first election under the new legislation was held in 1995, followed by subsequent elections in 2000, 2005, 2010, 2015, and 2020.

Evolution of Election Conduct Mechanism in India

Paper Ballot System:

- Voters marked ballot papers for chosen candidates/parties
- Manual counting by election officials
- Pros: Simplicity, ease of understanding, transparent counting
- Cons: Ballot stuffing, booth capturing, manipulation, fraud allegations

Introduction of EVMs:

- Need for efficient, tamper-proof voting led to EVM introduction
- EVMs electronically record votes, reducing manual processes
- 1982: First EVM usage in North Paravur Assembly, Kerala
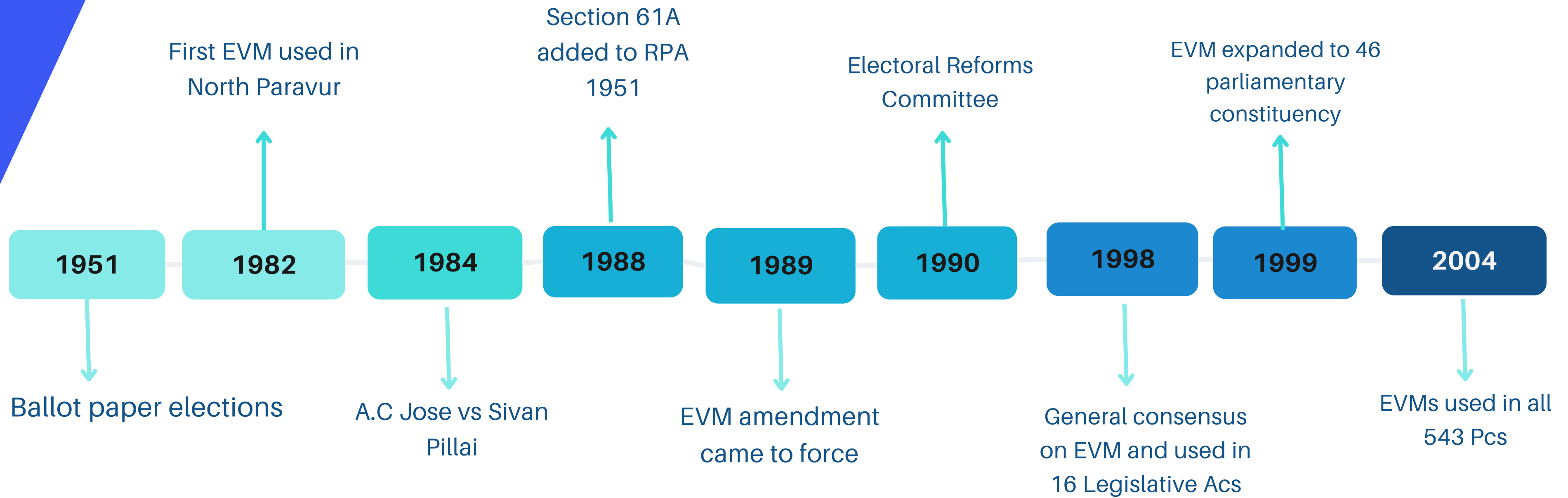- 1984: Supreme Court case A.C. Jose v. Sivan Pillai challenged EVM legality

Legislative Provisions for EVMs:

- 1989: Section 61A added to RPA 1951, granting ECI authority for EVM use
- 2001: Supreme Court upheld Section 61A in AIADMK v. Chief Election Commissioner

Key RPA 1951 Amendments for EVMs:

- Section 58: Fresh poll procedures
- Section 135A: Offences of booth capturing
- Section 169: Central government rule-making authority in consultation with ECI

EVM TIMELINE

First EVM used in North Paravur

Section 61A added to RPA 1951

Electoral Reforms Committee

EVM expanded to 46 parliamentary constituency

1951 **1982** **1984** **1988** **1989** **1990** **1998** **1999** **2004**

Ballot paper elections

A.C Jose vs Sivan Pillai

EVM amendment came to force

General consensus on EVM and used in 16 Legislative Acs

EVMs used in all 543 Pcs

Evolution of Election Conduct Mechanism in Kerala

Early Elections:

- 1953: First local body election under Travancore-Cochin Panchayati Act, 1950
- 1957: ARC recommends decentralization and two-tier governance system
- 1963: Second local body election under Panchayati/Municipality Act, 1960

Post Constitutional Amendments:

- 1994: Kerala Panchayati Raj Act and Kerala Municipality Act enacted post 73rd and 74th amendments
- 1995: First election under new legislation
- 1995-2000: Paper ballot-based elections

Introduction of EVMs:

- 2005: EVMs introduced, partial use in elections
- 2010: Continued partial use of EVMs
- 2015: Full adoption of EVMs with 35,000 multi-post EVMs in rural areas and single-post EVMs in urban areas

Legislative Provisions for EVMs:

Kerala Panchayati Raj Act, 1994:

- Section 74A (2005): Introduction of EVMs
- Key Rules: 24G, 24H, 24I, 25A, 26A, 35A-35G, 41A, 42A, 42B, 43A, 46A, 48A, 48B

Kerala Municipality Act, 1994:

- Section 130A (2005): Introduction of EVMs
- Key Rules: 24G, 24H, 24I, 25A, 26A, 35A-35G, 41A, 42A, 42B, 42C, 46A, 48A, 48B

Technology and Elections

Technology evolution and elections

YEAR	Technology Introduction	Tech impact in India	Election Progress in India
Late 19th Century	Industrial Revolution - Mechanised manufacturing, steam power, railways	Advent of textile mills and railways, transforming India's economy and infrastructure	Transformation of economy and infrastructure with the advent of textile mills and railways.
1959	The first integrated circuits - Robert Noyce invented the first monolithic integrated circuit.	Advancement in electronics and microelectronics, laying the foundation for future technological innovations.	Development of integrated circuits paved the way for electronic components used in modern electronic voting machines (EVMs), enhancing the efficiency and accuracy of the voting process.
1960s	Cloud computing emerged and is believed to have been invented by J. C. R. Licklider.	Leveraging cloud technology for efficient data storage and processing in various sectors, including governance and elections.	Cloud technology facilitates the storage, processing, and analysis of vast amounts of electoral data, enabling efficient voter registration, election management, and result dissemination.
1970s	Direct-Recording Electronic (DRE) machines - First came into widespread use.	Introduction of electronic voting machines (EVMs), revolutionizing the voting process.	Adoption of EVMs revolutionized the voting process, leading to faster tabulation of results and increased transparency in elections.

Technology evolution and elections

| YEAR	Technology Introduction	Tech impact in India	Election Progress in India
1971	Introduction of Microprocessors - Miniaturisation of computing power, leading to the birth of personal computers.	Embrace of microprocessor technology leading to the growth of the IT industry and digital literacy.	Microprocessor technology facilitated the development of electronic voting machines (EVMs), enhancing the efficiency and accuracy of the voting process.
1975	Emergence of microcomputers - The introduction of the Altair 8800, the first personal computer kit.	Technological advancements in space exploration fostering satellite-based communication and remote sensing capabilities.	Technological advancements in space exploration fostered India's satellite-based communication and remote sensing capabilities, aiding in electoral planning, monitoring, and communication in remote areas.
1982	Introduction of the Commodore 64, a pioneering home computer with advanced graphics and sound capabilities.	Improved communication, remote monitoring, broadcasting of election-related information, and emergency communication during elections facilitated by satellite launches.	Enhanced communication, remote monitoring, broadcasting of election-related information, and emergency communication during elections facilitated by satellite launches.
1990	World Wide Web - Birth of the internet, connecting the world and transforming communication and information access.	Liberalization of the Indian economy, leading to the growth of IT and software industries and the emergence of internet connectivity.	The internet revolutionized voter information dissemination, voter registration, political campaigning, and election monitoring through online platforms and social media.

Technology evolution and elections

YEAR	Technology Introduction	Tech impact in India	Election Progress in India
Early 2000s	Implementation of Cybersecurity Measures - Safeguarding digital infrastructure and data from cyber threats.	Bolstering cybersecurity posture with the establishment of CERT-In and other cybersecurity initiatives.	Cybersecurity measures critical for protecting electoral databases, voter information, and election infrastructure from cyberattacks, ensuring the integrity and confidentiality of the electoral process.
2007	Introduction of the iPhone and Android - Pioneering smartphones, merging communication, computing, and multimedia capabilities.	Smartphone revolution in India, growth of mobile connectivity.	Smartphone technology enabled the development of mobile applications for voter education, election monitoring, and real-time reporting of electoral irregularities, enhancing transparency and accountability.
2009	Emergence of Blockchain and Distributed Ledger Technology (DLT) - Offering secure and transparent digital transactions.	Exploration of blockchain technology applications across various sectors, including governance.	Blockchain technology holds promise for secure and tamper-proof electoral processes, ensuring the integrity of voter registration, ballot casting, and result tabulation.
2014	Introduction of 4G LTE (Long-Term Evolution) technology, significantly enhancing mobile internet speeds and connectivity worldwide.	Launch of the Mars Orbiter Mission (Mangalyaan) by ISRO, showcasing India's prowess in space exploration. Introduction of VVPAT in Lok Sabha elections for the first time.	Increased utilisation of artificial intelligence and machine learning algorithms to enhance various aspects of the electoral process. Introduction of blockchain-based voting systems, ensuring heightened security, transparency, and integrity in elections through tamper-proof digital vote records, guaranteeing accurate election outcomes.

Technology saturation and diffusion time

INTEGRATED CIRCUITS & MICROPROCESSORS TO PERSONAL COMPUTERS & SMARTPHONES

From introduction of IC chips in 1959 and microprocessors in 1971 to creation of personal computer kit in 1975

Tech diffusion period- Nearly 15 years
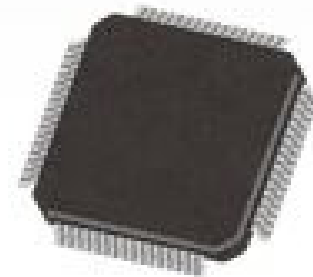
EMERGENCE OF WWW TO CYBERSECURITY MEASURES

World Wide Web emerged in the late 1990s and it took nearly a decade to set and furnish cybersecurity measures to regulate and govern the internet realm.

Tech diffusion period- Decade

DIRECT RECORDING ELECTRONIC MACHINE TO VVPAT

DRE machine technology took around 4 decades to be implemented in VVPAT machine for Electronic voting.

Tech diffusion period- 4 decades
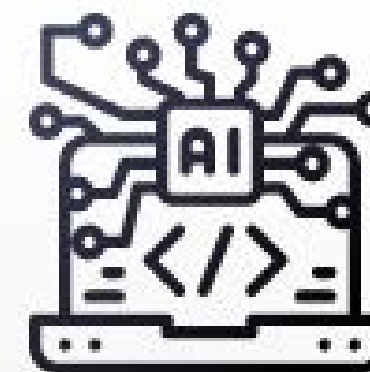
CLOUD COMPUTING TO ARTIFICIAL INTELLIGENCE

Cloud computing emerged in 1960s and its metamorphosis into advanced technologies like AI took decades of technological evolution

Tech diffusion period- 6 decades
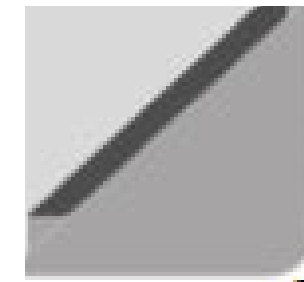
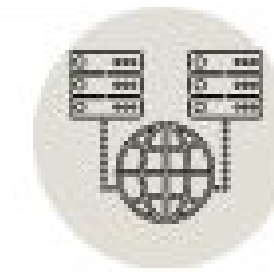# Technological evolution of EVMs:

M1 EVM
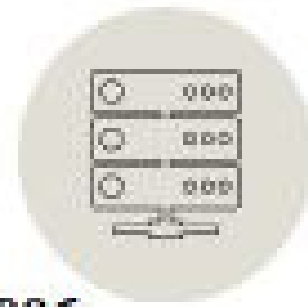
First model of EVM made **pre 2006**

- M1 EVMs were incompatible with VVPAT
- Last used in 2014 general elections
- Early electronic technology and primarily utilized basic micro controllers for processing and storing vote data.
- Not connected to external sources or internet
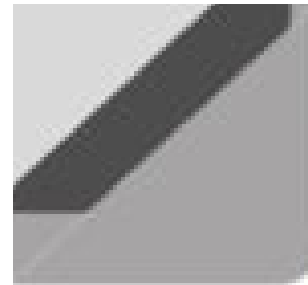- Limited memory capacity.

M2 EVM

EVMs manufactured between **2006-2012**

- Introduced after Technical Evaluation Committee for enhanced and improved technology
- Real-time setting of each key press to detect and prevent malicious key presses.
- Encrypted communication between Ballot Unit (BU) and Control Unit (CU) to prevent hacking

M3 EVM

Manufactured from **2013**

- Latest generation technology for enhanced security and encryption
- Include tamper detection and self diagnostics feauture
- One time programmable microcontroller for enanced security
- Standalone machinie not connected to any internet to prevent hacking

Distributed Ledger Technology (DLT)

Peer-to-Peer Network:

- Participants maintain identical ledger copies.
- Decentralized to ensure redundancy and fault tolerance.

Consensus Mechanisms:

- Proof of Work (PoW) or Proof of Stake (PoS) validate transactions.
- Ensures agreement on ledger state among all participants.

Security Features:

- Cryptographic nature ensures data security.
- Transactions cryptographically signed for authenticity and integrity.
- Cryptographic hashing creates immutable transaction chain.

Interoperability:

- Enables seamless communication and data exchange across platforms.
- Facilitates integration with various networks.

Benefits of DLT:

- Efficient, enhanced, and secure framework for managing data and transactions.
- Decentralized architecture, cryptographic security, consensus mechanisms, and interoperability enhance overall reliability.

Blockchain Technology

Blockchain Basics:

- Built on a network of computers or nodes.
- Data stored in blocks linked chronologically, forming a chain.
- Decentralized: No single entity controls the entire network.

Functionality Overview:

- Entry Encryption and Transmission: New entries encrypted and transmitted for validation.
- Validation and Consensus: Peer-to-peer node validation ensures authenticity, agreement via consensus mechanisms like Proof of Work.
- Immutable Recording: Valid transactions grouped into blocks and permanently recorded on the blockchain.

Accessibility and Control:

- Public Blockchains: Permissionless, anyone can join and transact.
- Private Blockchains: Permissioned, require authorization, prioritizing privacy and control.

Utilization in Elections:

Five-stage technological division:
- Blockchain platform selection.
- Consensus algorithm determination.
- Security and privacy techniques integration.
- Authentication and identity verification implementation.
- Additional cryptography, development, and testing requirements.

Suitable Consensus Mechanisms:

Proof of Authority (PoA) and Practical Byzantine Fault Tolerance (PBFT) are best suited for E-voting.

- PoA relies on trusted validators, crucial for identity verification.
- PBFT ensures agreement despite malicious actors, enhancing security.

Security and Privacy Considerations:

- Techniques like Zero-Knowledge Proofs, Homomorphic Encryption, and Biometric Authentication ensure integrity, confidentiality, and fraud prevention.
- Multi-step authentication, OTPs, Aadhaar ID verification, and PKI-based X 509 certificates add layers of security.

Additional Technological Requirements:

- Cryptography techniques, smart contract development platforms, and testing tools like Solidity, Remix, Ganache, Hyperledger Caliper, Grafana, and Gatling are essential for E-voting systems.
- Tools like SHA, AES, Schnorr signature, and SM2 algorithm ensure data security and digital signature verification.

Short video explanation of DLT and Blockchain
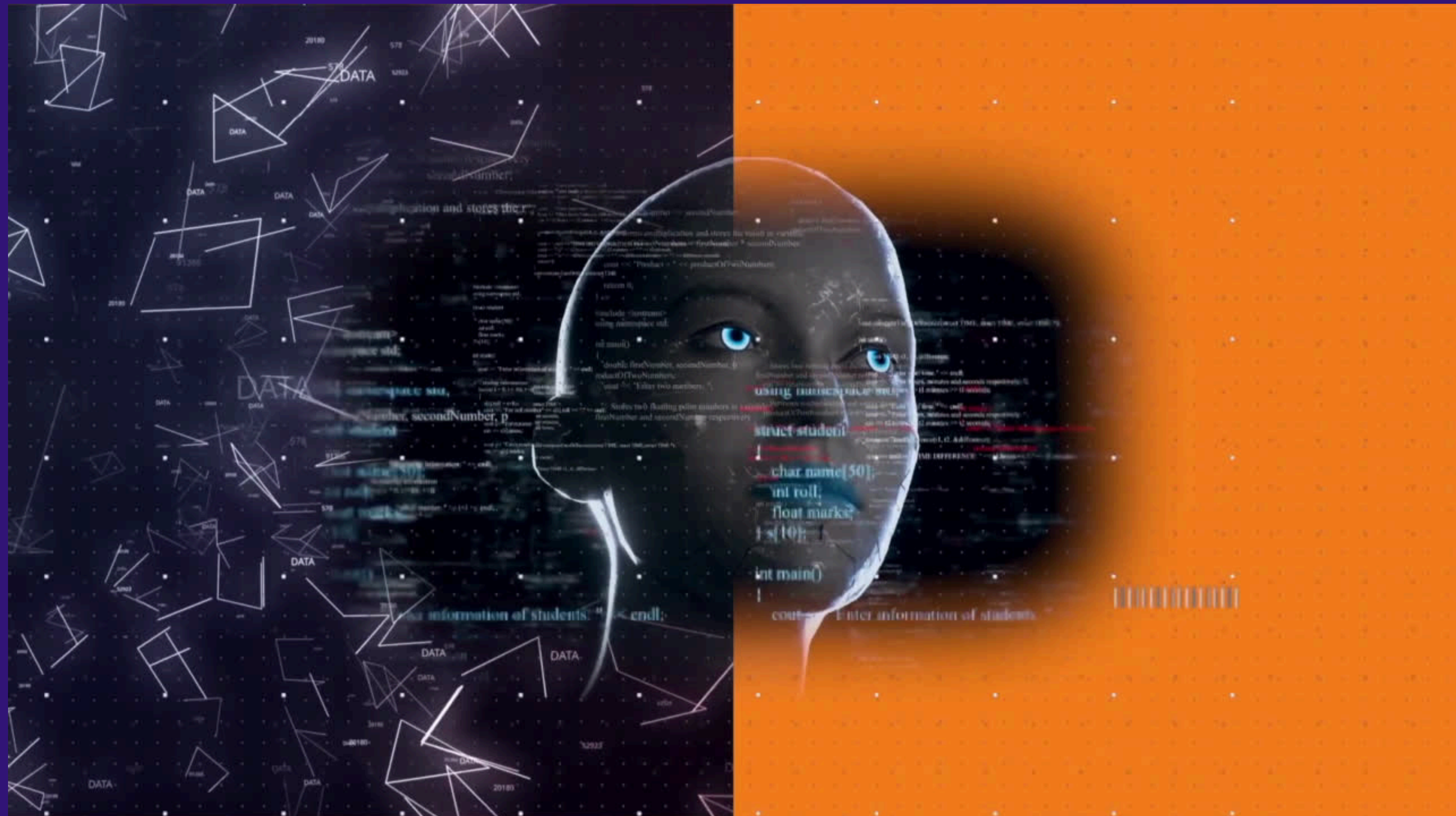
Development and discussions regarding technological upgradation for election management in India.

Webinar by ECI

Oct 30, 2019: Chief Election Commissioner Sh Sunil Arora at IIT Madras.
Aug 10, 2020: ECI & Tamil Nadu e-governance webinar on blockchain voting.
- Emphasis on trust, integrity, and secrecy in elections
- Experts: Prof K Vijay Raghavan, Prof Rajat Moona, Prof Bhaskar Ramamurthi, Sandra Ro, Monique Bachner, Ismael Arribas

ECI's Initiative and Prototype Development

Dec 28, 2022: ECI's letter to political parties
- Importance of addressing domestic/migrant voters
- Reference to Supreme Court orders on remote voting
- ECI proposed an RVM machine

Proposed RVM (Remote Voting Machine) Features:

- Remote Control Unit (RCU)
- Remote Ballot Unit (RBU)
- Remote VVPAT (RVVPAT)
- Remote Symbol Loading Unit (RSLU)
- Constituency Card Reader (CCR) and Public Display Control Unit (PDCU)

Proposed Voting and Counting Process

Voting Process:
- Voter identity verification by Presiding Officers
- Constituency Card scanning and display on Public Display Unit and RBU
- Vote recording and RVVPAT slip generation

Counting Process:
- RCU records total votes for each candidate
- Results shared with Home ROs for transparent counting
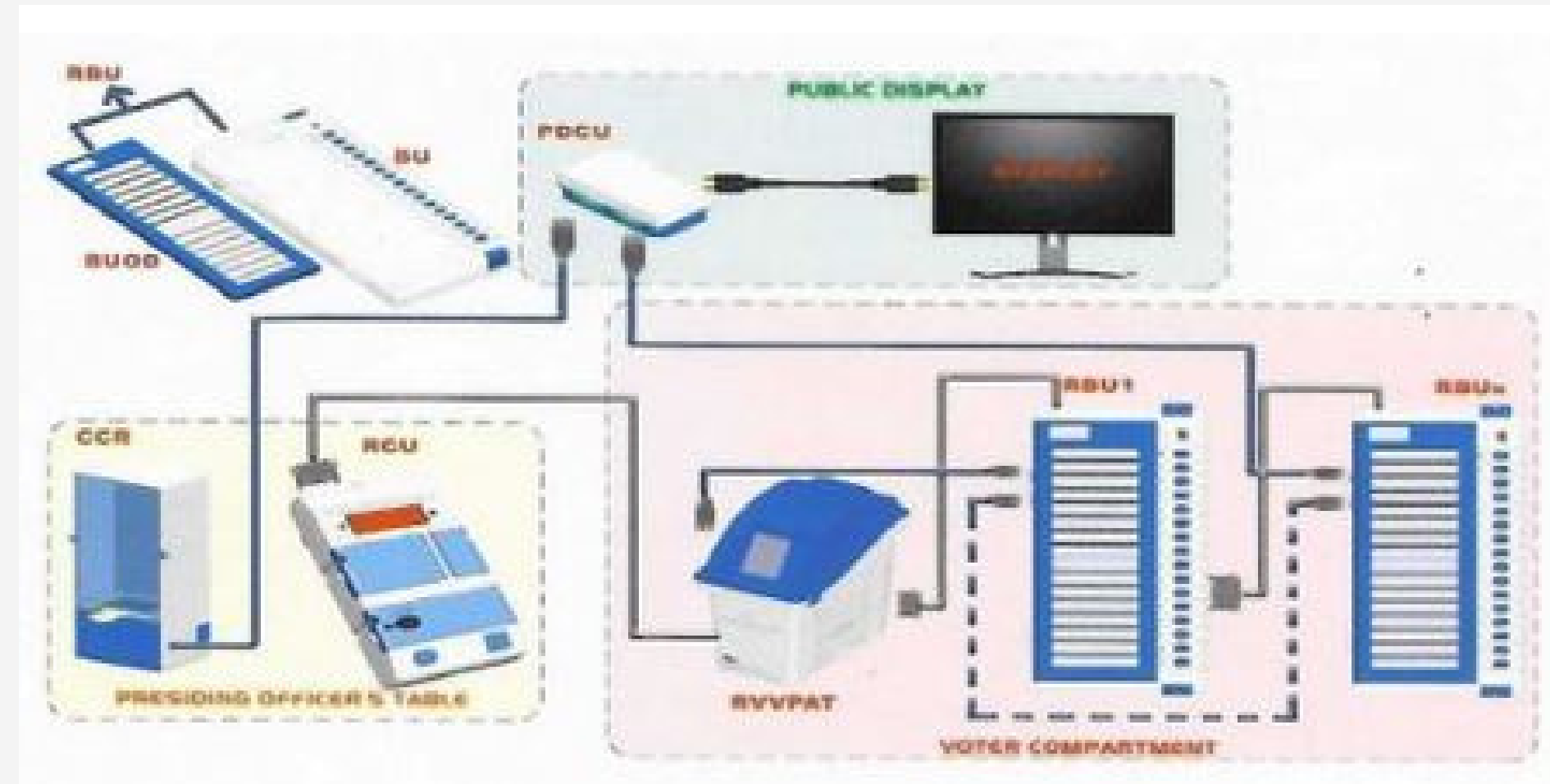
State-Level Technological Initiatives

Bihar:

- Enhanced Facial ID-based voting system with FaceTagr
- Verified 1.5 million individuals in 3000 booths
- SvaDESH app for Face ID-based election conduct

Telangana:

- DLT-based E-voting application by TSEC
- Developed by C-DAC with ITE&C Department support
- Mobile phone-based voting for eligible voters
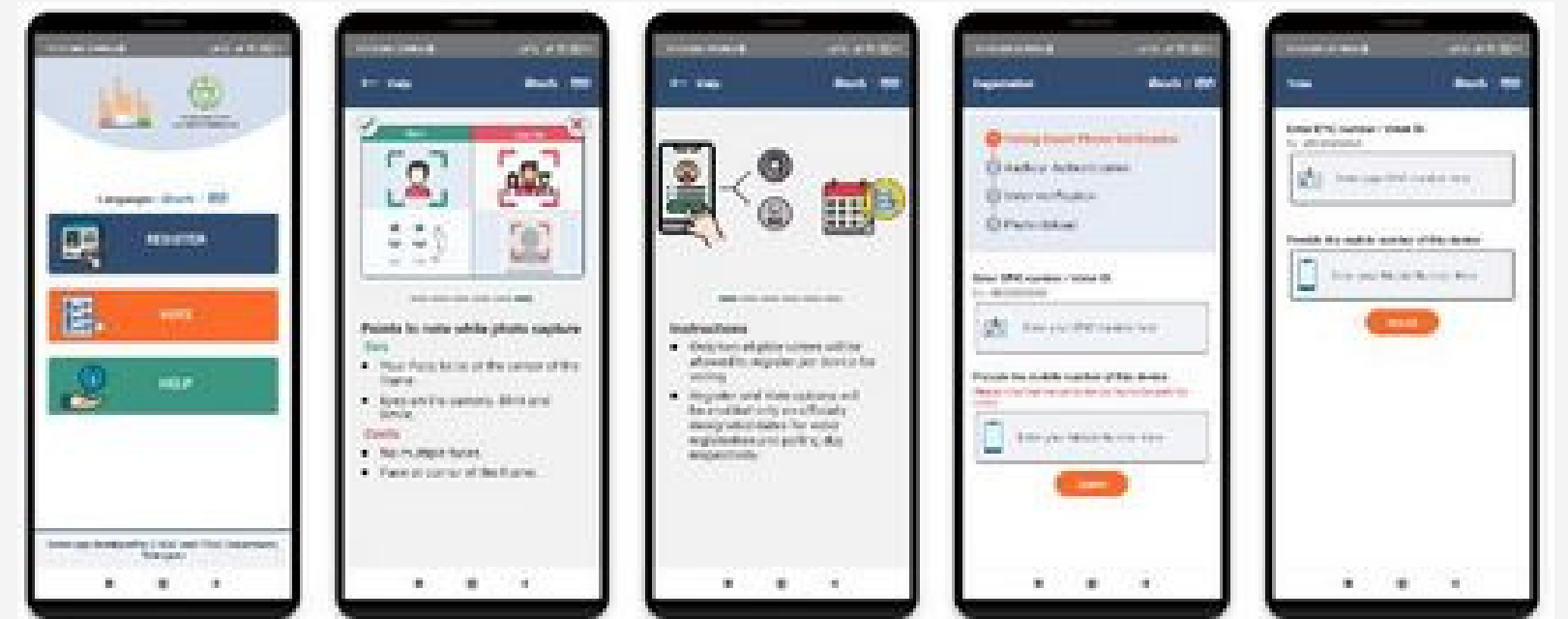
Policy proposals for technological upgradation of election conduct mechanisms in local body elections, Kerala

Blockchain based RVM kiosk

Blockchain based Mobile voting application

Blockchain based RVM kiosk

Concept: Networked to a blockchain system.
Eliminates: Physical ballot storage, VVPAT components.
Benefits:

- Tamper-proof vote recording
- Hack-proof database

Technology Behind RVM Kiosk

Digital Interface: Networked to blockchain
AI-enabled Biometric Verification:

- Face ID with retina scanner
- Fingerprint scanner

Components:

- Digital display interface
- Processor and RAM
- Real-time encryption

Voting Process Using Blockchain RVM Kiosk

1. Identification/Authentication Phase:

  - Choose ID: Aadhaar or Voter ID
  - Biometric verification (Face ID, retina scan, fingerprint)
  - AI matches biometric data with existing database
  - Constituency and candidate list displayed

2. Ballot Registration Phase:

  - Select preferred candidate
  - Confirmation pop-up
  - Digital VVPAT and unique serial code displayed

Benefits of Blockchain RVM Over ECI's Prototype
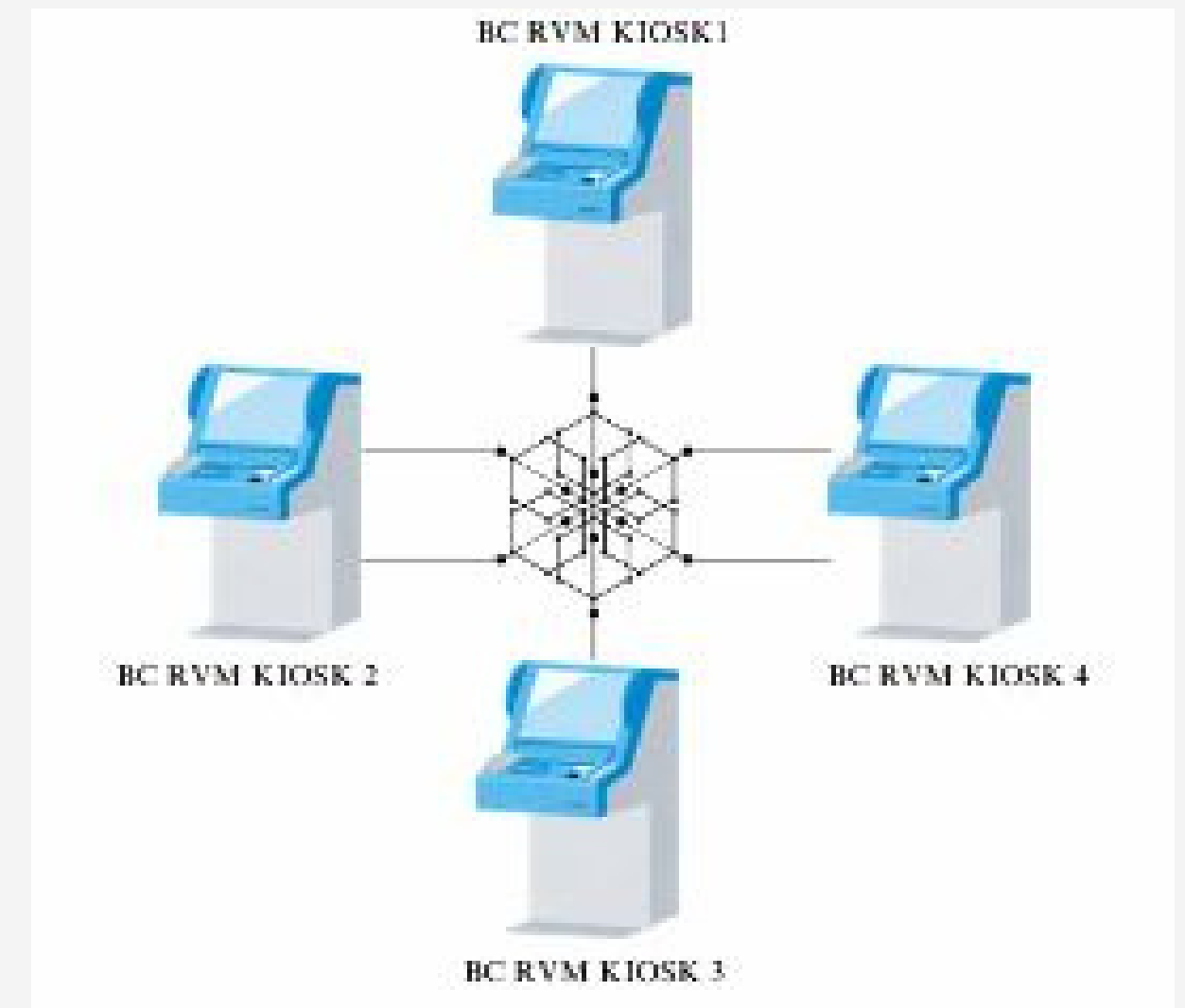
Cost Benefits:

- Reduced physical components
- Lower human resource requirements
- Automated processes cut election costs

Security and Integrity:

- Real-time encryption
- Elimination of physical ballot storage
- Secure and transparent voting process

Speed:

- Faster election process
- Reduced queue times
- Encourages higher voter participation

Blockchain-Based Mobile Voting Application

- Blockchain-based mobile application for Android and iOS.
- Networked to a blockchain ecosystem for encrypted vote registration.
- Features facial recognition and fingerprint security.

Technology behind M-Voting app

- Face ID and facial recognition for secure login.
- AI-enabled biometric verification.
- Background application restriction for security.
- IP address tracing to prevent multiple votes from one device.
- Allows up to 2 votes per device with proper authentication.
- Mandatory identification using Voter ID or Aadhar ID.
- Biometric attendance marking with facial recognition and fingerprint authentication.

Voting Process

- Voter authentication through biometrics.
- Selection of constituency and candidates based on ID.
- Confirmation window for vote assurance.
- Digital VVPAT generation with unique alpha-numerical code.

Security and Encryption

- Encrypted vote input into the blockchain network.
- Decryption possible only by the Election Commission during vote counting.
- Enhanced security features to ensure vote integrity.

Benefits of Blockchain-Based Mobile Voting Application

- Increased voter convenience and participation.
- Enhanced security and fraud prevention.
- Real-time vote registration and transparency.
- Efficient voter verification and authentication.
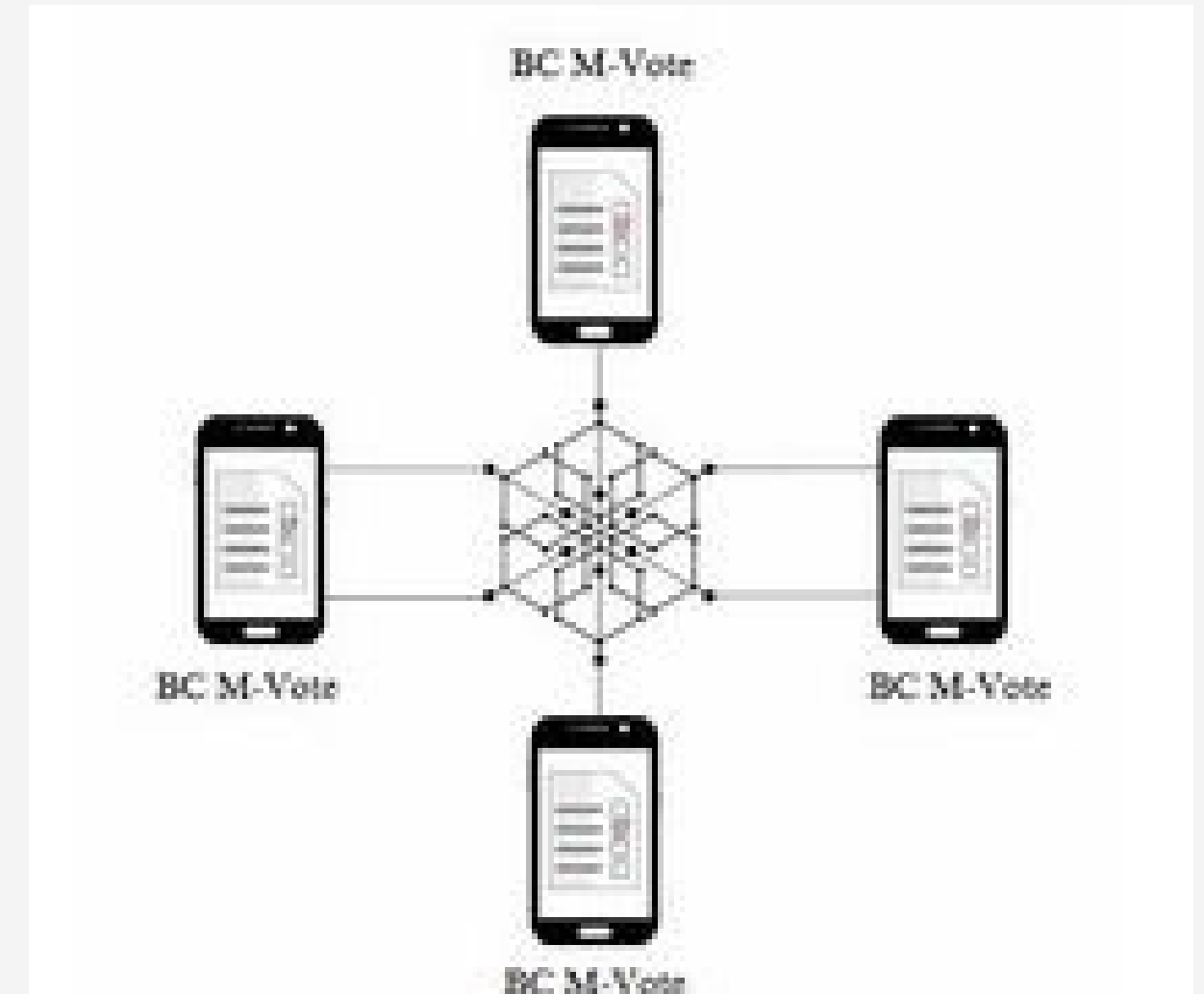
Implementation strategies for the proposed policy

Legislative Changes for Policy Implementation:

- legislative amendments.
- Reference to Gujarat's legislative amendment for E-voting as a case study.

Amendments in Kerala Municipality Act 1994

- Amendment to Section 130B to include provisions for Remote Voting and Mobile Voting on blockchain technology.
- Addition of rules for using proposed machines in accordance with election conduct rules.

Amendments in Kerala Panchayati Raj Act 1994

- Amendment to Section 74B to include provisions for Remote Voting and Mobile Voting on blockchain technology.
- Addition of rules for using proposed machines in accordance with election conduct rules.

Systemic/Institutional Changes for policy implementation:

1. Stakeholder Mapping and Awareness

- Identification of affected stakeholders.
- Importance of stakeholder awareness and education.

Awareness Campaigns for Election Personnel
- Training on technicalities and legalities of blockchain-based voting.
- Importance of equipping personnel with necessary technical knowledge.

Voter Education and Empowerment
- Massive campaign efforts via social media, mainstream media, and press releases.
- Familiarizing voters with the new technology and voting method.

Convincing Establishments and Institutions
- Engaging political parties and other key establishments.
- Emphasizing the tamper-proof nature and increased voter participation.
- Highlighting transparency and integrity of the election process.

2. Technological Enhancement

- Equipping the Election Commission with necessary technological infrastructure.
- Creating a special technical wing or outsourcing to trusted technological consultancies.
- Developing well-trained human resources with technical and legal knowledge.
- Facilitating seamless election conduct using the proposed technology.