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INDIA'S PATH TOWARDS TECHNOLOGICAL INDEPENDENCE

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Introduction

India's journey toward technological independence has gained urgency in the modern context, where geopolitical conflicts increasingly **rely on software, drones, and cyber capabilities rather than conventional weapons**. True autonomy now requires more than political freedom-it demands control over critical digital infrastructure and technology, including operating systems, databases, and foundational software.

India's present technological status

India does not have its own operating systems, databases, or foundational software that it can fully trust.

Most systems are dependent on external platforms, e.g., Linux or Android, which are open-source but not fully under India's control.

The country depends heavily on foreign software, hardware, and cloud services, making it vulnerable in areas like cybersecurity and Artificial Intelligence (AI).

Need to have technological sovereignty

Security Concerns

- Geopolitical conflicts now involve cyberattacks, software, and drones, not just conventional weapons.
- Dependency on foreign tech makes India vulnerable to cyberattacks and misuse of AI/cloud services.

Dependence on Foreign Technology is Risky

- Outsourcing and cloud services can be stopped by foreign powers anytime.
- Lack of domestic control over critical infrastructure poses strategic and national security risks.

Realising the vision of Atmanirbhar Bharat

India currently lacks foundational software like operating systems, databases, trustable tech platforms.

- Developing indigenous tech allows self-reliance and control over critical systems.

Economic and Strategic Benefits

- Technological sovereignty creates new industries, jobs, and R&D opportunities.
- Reduces costs associated with licensing and dependence on global players.

Building Indigenous Talent

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- Encourages skill development in hardware design, software engineering, and system architecture.
- Helps assemble dedicated teams to work on India-specific tech solutions.

Strategic Autonomy

- Controlling critical technology allows India to act independently in international affairs.

Strengthens national security, economic growth, and global competitiveness.

Challenges that India faces in achieving tech independence

1. Heavy Dependence on Foreign Technology

India imports critical technologies in semiconductors, aerospace, defense, and advanced machinery.

Example: Most of India's high-end chips and defense avionics are imported from the US, Israel, or Russia.

2. Limited R&D Investment

India spends ~0.8–1% of GDP on research & development, far below countries like the US (~3%) or China (~2.4%) which slows innovation and development of indigenous technologies.

Example: India is still developing next-gen AI chips and advanced biotech solutions.

3. Skilled Human Resource Shortage

Shortage of experts in cutting-edge fields like AI, quantum computing, nanotech, and advanced manufacturing.

Example: India faces talent crunch in semiconductor design, resulting in dependency on global firms for chip design.

4. Inadequate Infrastructure

Insufficient industrial and research infrastructure limits domestic production of high-tech products.

Example: India relies on foreign fabs for semiconductor manufacturing; domestic plants are limited and underdeveloped.

5. Slow Technology Commercialization

Many innovations in Indian research labs fail to reach market due to poor industry-academia collaboration.

Example: DRDO and ISRO develop advanced tech, but mass commercialization is slow.

6. Regulatory and Policy Challenges

Complex regulations and slow approvals hinder rapid adoption and scaling of indigenous tech.

Example: Startups in deep-tech sectors face delays due to multiple licensing and compliance requirements.

7. Intellectual Property (IP) Gaps

India lags in filing patents for cutting-edge tech, reducing competitive edge.

Example: Fewer patents in AI, quantum computing, and advanced biotech compared to China or the US.

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8. Global Geopolitical Pressures

Dependence on foreign components exposes India to supply chain disruptions during geopolitical tensions.

Example: Russia-Ukraine conflict impacted defense imports; US-China trade restrictions affect electronics imports.

What can be done to reduce India's tech dependence?

1. Promote Indigenous R&D: Increase government and private sector investment in research and development.

- **Example:** *DRDO and ISRO* have developed indigenous missile systems and satellite technology, reducing reliance on imports.

2. Encourage Domestic Manufacturing of Electronics: Incentivize local production of semiconductors, chips, and electronic components.

- **Example:** *Semiconductor Manufacturing Incentive Scheme (SMIC), 2022* aims to attract chip manufacturing to India.

3. Strengthen Tech Startups: Support startups focusing on AI, robotics, quantum computing, and software solutions through funding and incubation.

- **Example:** *Digital India initiative* has helped tech startups develop homegrown solutions in fintech, edtech, and healthtech.

4. Reduce Dependence on Foreign Software: Promote development and adoption of open-source software and Indian-made applications.

- **Example:** *Bharat Operating System Solutions (BOSS)* developed by C-DAC for government and enterprise use.

5. Secure Critical Supply Chains: Identify strategic tech sectors (chips, telecom, defense) and reduce imports. Encourage local production and partnerships.

- **Example:** *5G rollout plans* include indigenous equipment from companies like Tejas Networks and BEL.

6. Invest in Skill Development: Train a workforce in emerging technologies like AI, machine learning, and cybersecurity.

- **Example:** *National AI Portal and AI Skilling programs* under NITI Aayog aim to build local expertise.

7. Encourage Public-Private Partnerships (PPP): Foster collaboration between government, research institutes, and private companies for innovation.

- **Example:** *BharatNet project* connects villages using locally developed networking solutions.

8. Strengthen Intellectual Property (IP) Ecosystem: Protect Indian innovations through patents and IP rights to encourage innovation domestically.

- **Example:** Increased filing of patents in *AI, biotech, and renewable energy* sectors by Indian companies.

Conclusion:

Reducing India's technological dependence is crucial for achieving strategic autonomy, economic growth, and global competitiveness. By strengthening indigenous R&D, promoting domestic manufacturing, skilling the

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workforce, and fostering public-private collaboration, India can gradually move towards technological self-reliance.