Cybersecurity Breaches in India: 2025

A Comprehensive Research Paper on Threats, Vulnerabilities, Incident Response, Legal Frameworks, and Prevention Strategies

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1. Executive Summary

The year 2025 marked a watershed moment for cybersecurity in India. According to Quick Heal Technologies' India Cyber Threat Report 2026, over 265 million cyberattack attempts were recorded across the country. The Indian Computer Emergency Response Team (CERT-In) handled over 29.44 lakh (approximately 2.94 million) cybersecurity incidents during the year, issuing 1,530 alerts, 390 vulnerability notes, and 65 advisories.

The threat landscape was shaped by three converging forces: (a) a dramatic surge in ransomware targeting enterprises, with a 55 percent increase over 2024 figures; (b) geopolitically motivated hacktivist campaigns triggered by the Pahalgam terror attack and India's Operation Sindoor in May 2025, which alone generated approximately 1.5 million cyberattack attempts; and (c) the continued exploitation of cloud misconfigurations, insecure APIs, and unpatched legacy systems across critical infrastructure.

The financial impact was substantial. Cybercrime losses in India are projected to reach INR 20,000 crores across sectors in 2025, with the banking and financial services sector bearing the heaviest burden at INR 8,200 crores. The global average cost of a data breach in 2025 reached approximately USD 4.4 million according to IBM's annual Cost of a Data Breach report.

This research paper provides a comprehensive, evidence-based analysis of the most significant cybersecurity breaches affecting India in 2025. It examines the vulnerable technologies and platforms that were exploited, the technical loopholes leveraged by attackers, incident response measures taken, the relationship between the Digital Personal Data Protection (DPDP) Act and breach preparedness, and actionable technologies and frameworks for prevention. Executable code snippets for defensive security operations are included.

Key Statistic: India ranked among the top five most-targeted nations globally in 2025. CERT-In reported that phishing remained the most prevalent attack vector at 22 percent of incidents, while unauthorized network scanning and exploitation of vulnerable services collectively accounted for over 80 percent of cybersecurity incidents.

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2. Major Cybersecurity Breaches in India - 2025

This chapter documents the most significant cyber incidents affecting Indian organizations in 2025. Each incident is described with confirmed facts drawn from regulatory filings, established cybersecurity news outlets, and official advisories. Where details remain unconfirmed, this is explicitly noted.

2.1 Tata Technologies Ransomware Attack

On January 31, 2025, Tata Technologies Limited, a subsidiary of Tata Motors operating in 27 countries with over 12,500 employees and annual revenue of approximately USD 600 million, disclosed a ransomware incident to the Bombay Stock Exchange (BSE) and National Stock Exchange (NSE). The company reported that the attack affected a limited portion of its IT infrastructure, forcing the temporary suspension of some IT services as a precautionary measure.

In early March 2025, the Hunters International ransomware group publicly claimed responsibility on its dark web leak site. The group alleged exfiltration of 1.4 terabytes of data comprising over 730,000 files including Excel spreadsheets, PowerPoint presentations, PDF documents, employee personal details, purchase orders, and contracts with customers in India and the United States. Tata Technologies did not confirm the data theft claim. The attack reportedly occurred on a weekend, a common tactic used by threat actors to exploit reduced IT staffing.

Hunters International, which surfaced in late 2023, is a ransomware-as-a-service (RaaS) operation suspected to be a rebranded version of the Hive ransomware gang, which was disrupted by a joint FBI, German, and Dutch law enforcement operation in 2023. Notably, Hive had previously targeted Tata Power in October 2022.

Attribute	Detail
Date Disclosed	January 31, 2025
Threat Actor	Hunters International (RaaS)
Data Claimed	1.4 TB / 730,000 files
Sector	Engineering / Automotive / Aerospace
Impact on Operations	Some IT services suspended; client delivery unaffected
Root Cause	Under investigation; weekend timing exploited

Sources: TechCrunch (Mar 2025), The Record (Jan 2025), Bleeping Computer, BSE Filing

2.2 Angel One Cloud Data Breach

On February 27, 2025, Angel One, one of India's largest listed retail stockbroking firms with over 30 million clients, disclosed a data breach involving unauthorized access to its Amazon Web Services (AWS) resources. The breach was not detected by internal systems but was flagged by a dark-web monitoring partner that identified client data being offered on hacker forums.

Angel One immediately rotated all AWS credentials and credentials for other connected applications, and engaged an external forensic investigation partner. The company confirmed in its regulatory filing that client securities, funds, and login credentials were not compromised. However, personal information including names, email addresses, mobile numbers, and client holding data was exposed. The stock dropped approximately 4.7 percent following the disclosure. A prior breach in April 2023 had also affected an

undisclosed number of customers, suggesting persistent security gaps.

The breach highlights the risks inherent in cloud-native fintech architectures. Potential vectors include misconfigured S3 buckets, exposed API gateways, overly permissive IAM roles, or compromised CI/CD pipeline credentials. AWS has not commented on the incident.

Sources: SecurityWeek (Mar 2025), Business Standard (Feb 2025), Inc42 (Feb 2025), MSSP Alert (Mar 2025)

2.3 Niva Bupa Health Insurance Data Extortion

On February 21, 2025, Niva Bupa Health Insurance reported receiving emails from an anonymous sender claiming possession of customer data. The company initiated an urgent investigation and mitigation process. By early March, reports indicated escalation: the threat actor allegedly posted data to a domain named 'NivaBupaLeaks.com' along with a payment demand. Niva Bupa pursued legal takedown actions.

The breach method, scope, and specific vulnerability exploited were not publicly disclosed. The incident represents a growing trend of extortion-based attacks targeting India's insurance sector, which handles large volumes of sensitive personal health information and Aadhaar-linked data.

Sources: Eventus Security (May 2025), court reporting (Mar 2025)

2.4 BSNL DDoS Attacks

Bharat Sanchar Nigam Limited (BSNL), India's state-owned telecommunications provider and fourth-largest ISP, suffered multiple DDoS attacks in April 2025 in the context of escalating India-Pakistan tensions following the Pahalgam terror attack. On April 23, BSNL websites were targeted using CLDAP (Connection-less Lightweight Directory Access Protocol) reflection amplification, with the attack lasting over 3 hours. On April 25-26, two consecutive DDoS attacks using NetBIOS reflection and NTP reflection amplification technologies hit the main website, each lasting over 30 minutes.

The attacks rendered BSNL's public portal inaccessible for several days, disrupting online bill payments, service requests, and customer support functions. As India's critical communications infrastructure provider with historical responsibility for railway communication systems, disruption to BSNL carries potential cascading effects on national infrastructure.

Sources: NSFOCUS Global (May 2025), Security Boulevard (May 2025), Eventus Security (May 2025)

2.5 President's Website DDoS Attack

Following India's Operation Sindoor in May 2025, the official website of the President of India was targeted with a DDoS attack that lasted approximately 19 hours. The attack was part of the broader wave of coordinated hacktivist campaigns tagged under #OpIndia, involving over 40 hacktivist groups from Pakistan, Bangladesh, Indonesia, Turkey, and other nations. Approximately 1.5 million cyberattack attempts targeted Indian systems in the days surrounding the military operation.

Sources: Quick Heal India Cyber Threat Report 2026, NewsBytes (Dec 2025), CloudSEK (Aug 2025)

2.6 National Power Grid Cyber Assault

India's national power grid was subjected to approximately 200,000 cyber intrusion attempts in 2025, many of which coincided with the post-Pahalgam geopolitical tensions. Attackers attempted to infiltrate operational technology (OT) systems through malware-infected email attachments sent to energy sector

employees. The attacks aimed to disrupt electricity supply but were contained. The incident underscores the exposure of critical infrastructure where IT and OT network convergence creates expanded attack surfaces.

Sources: Quick Heal India Cyber Threat Report 2026, CERT-In Advisories

2.7 Banking Sector S3 Bucket Exposure (Nupay/Aye Finance)

In September 2025, cybersecurity researchers at UpGuard discovered one of the most significant banking data exposures in Indian history. A publicly accessible Amazon-hosted storage server (S3 bucket) contained 273,000 PDF documents relating to bank transfers of Indian customers, with data linked to at least 38 different banks and financial institutions. The exposed documents contained completed transaction forms for the National Automated Clearing House (NACH) system, used for high-volume recurring transactions including salaries, pensions, and loan repayments.

Over half the sampled files referenced Aye Finance, an Indian lender that had filed for a USD 171 million IPO, with State Bank of India appearing as the next most frequently mentioned institution. Indian fintech company Nupay subsequently confirmed it had addressed a configuration gap in its Amazon S3 storage bucket. This incident exemplifies the cascading security risks created by reliance on third-party vendors and service providers.

Sources: cyberlawconsulting.com (2025), UpGuard Research

2.8 Pahalgam-Triggered Hacktivist Campaign (#OpIndia)

The Pahalgam terror attack on April 22, 2025, and India's retaliatory Operation Sindoor on May 7 triggered the largest coordinated hacktivist campaign against Indian digital infrastructure in recent history. According to Kochi-based cybersecurity firm Technisanct, over 200 cyber incidents were identified between April 22 and May 8. The Maharashtra Computer Emergency Response Team (MH-CERT) reported over 10 million intrusion attempts in the immediate aftermath.

DDoS attacks accounted for 55.5 percent of incidents, website defacements 35.5 percent, and data breach claims 7.5 percent. Over 40 hacktivist groups participated, including Keymous+, AnonSec, Electronic Army Special Forces, RipperSec, and Mysterious Team Pakistan. State-sponsored APT groups were also active: APT36 (Transparent Tribe) deployed Crimson RAT malware using phishing documents themed around the Pahalgam attack, while SideCopy deployed modified AllaKore RAT targeting Indian Ministry of Defence employees.

However, CloudSEK's investigation revealed that most hacktivist breach claims were significantly overblown, with alleged data leaks containing primarily publicly available information and DDoS attacks causing only brief service disruptions. The real threat came from APT36's targeted espionage operations.

Sources: CloudSEK (Aug 2025), Technisanct Report (May 2025), MH-CERT, SOCRadar (May 2025), Seqrite Labs

2.9 16 Billion Credential Leak (Global, Affecting India)

In June 2025, researchers uncovered the largest credential compilation in history, containing approximately 16 billion usernames and passwords aggregated from years of credential theft attacks, infostealer malware logs, phishing campaigns, and previously disclosed breaches. CERT-In issued an urgent advisory (CTAD-2025-0024) on June 23, 2025, as the leaked data included credentials from platforms widely used in India including Apple, Google, Facebook, Telegram, GitHub, and government portals.

The data primarily originated from misconfigured public databases and malware that stole browser-stored credentials. A significant portion consisted of freshly harvested infostealer logs, making them dangerous for users who had not updated passwords or enabled multi-factor authentication.

Sources: CERT-In Advisory CTAD-2025-0024, Angel One News (Jul 2025), NewsBytes (Dec 2025)

2.10 Raymond Ltd IT Security Incident

On February 19, 2025, Raymond Ltd, the Indian textiles and fashion retail conglomerate headquartered in Mumbai, disclosed a cybersecurity incident affecting some of its IT assets. The affected systems were isolated for containment. The company stated that core systems and daily operations, including customer and store operations, continued unaffected. The root cause, whether data was exfiltrated, and the identity of the threat actor were not publicly confirmed.

Sources: Eventus Security (May 2025), BSE/NSE regulatory filing

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3. Most Vulnerable Tools, OSes, Databases, and Applications

3.1 Operating Systems and Platforms

In 2025, several operating system families and platform components were repeatedly exploited in attacks affecting Indian organizations. Microsoft Windows Server remained a primary target, particularly through CVE-2025-59287 (Windows Server Update Services RCE, CVSS 9.8). Legacy Windows deployments in government and public sector units, often running unpatched versions, provided reliable entry points. Linux-based systems were targeted through the Erlang/OTP SSH daemon vulnerability (CVE-2025-32433, CVSS 10.0), which affected telecom infrastructure built on Erlang technologies.

Android devices were significant targets for mobile-focused attacks, particularly through APT36's Crimson RAT campaigns that used malicious APK files disguised as legitimate government apps. iOS was also affected by use-after-free vulnerabilities allowing kernel-level code execution.

3.2 Databases

MongoDB emerged as a critical target in 2025. CVE-2025-14847 (MongoBleed), added to CISA's Known Exploited Vulnerabilities catalog on December 29, 2025, allowed unauthenticated attackers to remotely leak sensitive data from server memory through a flaw in zlib compression. Censys data showed over 87,000 potentially vulnerable MongoDB instances globally, with India among the top five affected nations. Wiz reported that 42 percent of cloud environments had at least one vulnerable MongoDB instance.

SQL injection and NoSQL injection remained prevalent vectors. OpenCart's default Divido payment module enabled unauthenticated database dumps. Legacy MySQL and PostgreSQL installations in government portals continued to suffer from weak authentication and unpatched known vulnerabilities.

3.3 Applications and Protocols

Application/Protocol	Vulnerability	CVSS	Impact
React Server Components	CVE-2025-55182 (React2Shell) - RCE	10.0	Unauthenticated RCE on web apps
Erlang/OTP SSH	CVE-2025-32433 - Pre-auth RCE	10.0	Telecom/IoT infrastructure
Apache Tomcat	RCE Flaw (CVSS 9.8)	9.8	Widespread web server compromise
Fortinet FortiWeb	CVE-2025-64446 - Auth Bypass	9.8	Firewall/WAF bypass
Palo Alto PAN-OS	Authentication Bypass	9.2	Perimeter security devices
Microsoft SharePoint	ToolShell Zero-Day RCE	9.0+	Enterprise collaboration
Oracle E-Business Suite	CVE-2025-61882 - Pre-auth RCE	9.8	Enterprise ERP/BI systems
Citrix NetScaler	CitrixBleed 2 - Session Hijack	9.4	VPN/Remote access bypass
CLDAP / NTP / NetBIOS	Reflection Amplification	N/A	DDoS amplification attacks

3.4 Cloud Infrastructure

Amazon Web Services S3 buckets remained the single most exploited cloud misconfiguration in Indian breaches during 2025. Both the Angel One breach and the Nupay/banking data exposure originated from improperly secured AWS resources. Misconfigured S3 buckets, excessive IAM permissions, exposed API gateways, and leaked cloud credentials in CI/CD pipelines were recurring themes. OAuth trust relationship abuse in Salesforce CRM environments also emerged as a major attack vector globally.

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4. Why These Applications Were Targeted

The targeting patterns observed in India's 2025 breach landscape were driven by a convergence of strategic, economic, and technical factors:

4.1 Rapid Digital Transformation Outpacing Security

India's digital growth, spanning digital payments, cloud computing, and government e-services, has significantly outpaced the implementation of corresponding cybersecurity measures. Many organizations, particularly small and medium enterprises, have struggled to match their security protocols to evolving threats. Cisco's 2024 Cybersecurity Readiness Index found that only 4 percent of Indian organizations had a 'mature' level of cybersecurity readiness.

4.2 Financial Sector as High-Value Target

With banking and financial services projected to bear INR 8,200 crores in cybercrime losses, the sector presents a lucrative target. The surge in demat accounts (151 million by March 2024) and digital transactions has created massive data repositories. Stock broking platforms like Angel One and banking intermediaries handling NACH transactions process millions of records daily, making them attractive targets for data exfiltration and extortion.

4.3 Geopolitical Motivation

The Pahalgam attack and Operation Sindoor created unprecedented geopolitical motivation for hacktivist campaigns. Over 40 groups coordinated attacks on Indian government, defence, financial, healthcare, and educational infrastructure. State-sponsored groups like APT36 and SideCopy exploited the emotional aftermath through themed phishing campaigns targeting defence personnel.

4.4 Legacy Infrastructure and Compliance Gaps

Government portals, BSNL, and power grid systems often run legacy software with known vulnerabilities. Multiple state e-governance portals lacked basic HTTPS encryption. Public-facing government applications exposed misconfigured APIs. Cybersecurity budgets at many institutions represent less than 1 percent of total IT expenditure. A 'checkbox approach' to compliance, where organizations focus on minimum regulatory requirements on paper while failing to implement robust practices, remains pervasive.

4.5 Third-Party and Supply Chain Risk

Nearly half of global organizations experienced security incidents originating from vendors or supply chains in 2025. The Nupay/banking S3 bucket exposure demonstrated how a single misconfigured third-party component can cascade across 38 financial institutions. Traditional banking regulations were not designed to address these cascading vendor risks.

5. Incident Response: What Was Done to Handle Breaches

The incident response actions taken across the major breaches of 2025 varied significantly in maturity, transparency, and effectiveness. Below is a synthesis of confirmed response measures:

Incident	Response Actions Taken
Tata Technologies	Isolated affected IT assets; suspended some services as precaution; engaged cybersecurity experts for root cause analysis; restored services; filed regulatory disclosure with BSE/NSE. Did not publicly confirm data theft claims.
Angel One	Dark-web monitoring partner detected breach; immediately rotated all AWS and application credentials; engaged external forensic partner; filed regulatory disclosure; publicly confirmed client funds/securities unaffected.
Niva Bupa	Launched urgent investigation upon extortion email; initiated legal takedown of leaked data domain; engaged mitigation processes. Details limited.
BSNL DDoS	Attacks identified and reported; website remained inaccessible for several days. No detailed public disclosure of mitigation techniques employed.
President Website	DDoS absorbed/mitigated after ~19 hours. Coordinated with CERT-In.
Power Grid	Attacks contained before causing operational disruption to electricity supply. IT-OT network segmentation cited as key defense.
Banking S3 Exposure	Nupay confirmed it addressed the S3 configuration gap after notification by UpGuard researchers. BSE issued cybersecurity advisory.
#OpIndia Campaign	CERT-In, MH-CERT coordinated national response; issued warnings to BFSI sector. CloudSEK and Seqrite Labs published threat intelligence. APT36 IOCs shared across security community.
16B Credential Leak	CERT-In issued urgent advisory CTAD-2025-0024 recommending immediate password changes and MFA activation for high-risk services.
Raymond Ltd	Affected IT assets isolated for containment; core operations continued; investigation underway. Limited public disclosure.

A notable pattern across these incidents is the gap between initial detection and comprehensive public disclosure. While CERT-In mandates 6-hour incident reporting, detailed public disclosures often took days to weeks. The Angel One incident stands out for relatively rapid public transparency, including same-day regulatory filing and acknowledgment.

6. Technical Loopholes Exploited

The breaches of 2025 revealed a set of recurring technical vulnerabilities that attackers consistently leveraged. This chapter categorizes the primary loopholes exploited:

6.1 Cloud Misconfigurations

- Publicly accessible Amazon S3 buckets containing sensitive financial documents (Nupay/banking exposure).
- Overly permissive IAM roles allowing unauthorized access to AWS resources (Angel One).
- Exposed API gateways in cloud-native microservices architectures.
- Leaked credentials in CI/CD pipelines enabling lateral movement.

6.2 Unpatched Software and Known CVEs

- Legacy Windows Server installations without critical security updates in government networks.
- Unpatched VPN appliances (Citrix, Fortinet, Palo Alto) providing initial access to corporate networks.
- MongoDB instances running default configurations with zlib compression enabled (CVE-2025-14847).
- Apache Tomcat and React Server Component deployments without security patches.

6.3 Social Engineering and Phishing

- APT36's phishing PDFs titled 'Pahalgam Terror Attack' deploying Crimson RAT via embedded macros.
- SideCopy's modified AllaKore RAT delivered through spear-phishing targeting defence personnel.
- Spoofed government domains (@gov.in, @nic.in, jkpolice.gov.in) in phishing campaigns.
- Fake government service websites (Aadhaar, National Portal of India) for credential harvesting.

6.4 DDoS Amplification Techniques

- CLDAP (Connection-less Lightweight Directory Access Protocol) reflection amplification.
- NTP (Network Time Protocol) reflection amplification.
- NetBIOS reflection.
- Mirai botnet ACK_FLOOD attacks.

6.5 Weak Authentication and Access Controls

- Password-only authentication (contributing to the 16 billion credential leak impact).
- Hardcoded credentials in non-production systems (globally observed in Red Hat GitLab breach).
- Absent or bypassed multi-factor authentication on VPN and cloud management consoles.
- Weak admin passwords on e-governance portals, many lacking basic HTTPS encryption.

6.6 Third-Party and Vendor Vulnerabilities

- Third-party fintech vendor (Nupay) misconfiguration exposing data of 38 banks.
- OAuth trust relationship abuse in CRM environments.

- Ransomware-as-a-Service models (Hunters International) reducing attack complexity.

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7. Unprecedented Breaches Without Prior Precedence

Several incidents in 2025 represented genuinely novel attack patterns or scales not previously observed in the Indian cybersecurity landscape:

7.1 Scale of Geopolitically Coordinated Cyber Operations

The #OpIndia hacktivist campaign represented an unprecedented scale of coordinated international cyber operations targeting Indian infrastructure. Over 40 hacktivist groups from multiple nations synchronized attacks with real-time military events. The 1.5 million attacks in the immediate aftermath of Operation Sindoor, the 19-hour DDoS on the President's website, and the 200,000 attempts on the power grid had no direct precedent in India's cyber history. While individual DDoS attacks and hacktivist campaigns have occurred before, the scale, coordination, and synchronization with kinetic military operations was new.

7.2 Banking Infrastructure Exposure via Third-Party

The Nupay/Aye Finance S3 bucket exposure was unprecedented in that a single third-party misconfiguration exposed NACH transaction data spanning 38 banks and financial institutions simultaneously. No prior Indian incident had demonstrated this degree of cascading third-party risk across the banking ecosystem.

7.3 16 Billion Credential Mega-Compilation

While credential compilations have existed before (e.g., the 'Collection' series), the 16 billion record dataset represented an order-of-magnitude increase and included freshly harvested infostealer logs alongside historical data, creating a qualitatively different global account takeover resource. CERT-In's emergency advisory specifically acknowledged the unprecedented nature of this threat.

7.4 APT36's Real-Time Exploitation of Terror Events

While APT36 has a long history of targeting Indian institutions, the speed and specificity with which the group weaponized the Pahalgam terror attack, deploying Crimson RAT via thematically tailored phishing documents within 48 hours of the event, represented a new level of operational agility in combining kinetic events with cyber operations.

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8. India's DPDP Act and Breach Anticipation

The Digital Personal Data Protection Act, 2023, received presidential assent on August 11, 2023, making India the 19th G20 nation to pass comprehensive data protection legislation. The DPDP Rules were formally notified on November 13, 2025, transitioning the framework from a principles-based law to an enforceable compliance regime. This chapter examines whether and how the Act anticipates the types of breaches observed in 2025.

8.1 Key Provisions Relevant to Breaches

- **Section 8 (Security Safeguards):** Mandates that Data Fiduciaries implement 'reasonable security safeguards' to prevent personal data breaches, including encryption, access control, and data backups to ensure confidentiality, integrity, and availability.
- **Breach Definition (Section 2(u)):** Defines a personal data breach as 'any unauthorized processing of personal data or accidental disclosure, acquisition, sharing, use, alteration, destruction or loss of access to personal data' that compromises confidentiality, integrity, or availability.
- **Breach Notification:** Data Fiduciaries must notify the Data Protection Board (DPB) and affected Data Principals 'without delay' upon breach discovery, with detailed reporting within 72 hours. The DPDP Rules 2025 further mandate breach detection mechanisms and maintenance of logs.
- **Penalties:** Up to INR 250 crore (~USD 28 million) for failure to implement adequate security safeguards leading to a breach; up to INR 200 crore for failure to notify the DPB and affected individuals; up to INR 200 crore for violations involving children's data.
- **Significant Data Fiduciaries (SDFs):** Must appoint Data Protection Officers, conduct Data Protection Impact Assessments (DPIAs), and undergo regular audits by independent auditors.

8.2 CERT-In's Dual Reporting Framework

India operates one of the world's most stringent dual breach notification frameworks. Under CERT-In's 2022 Directions, all entities must report cybersecurity incidents within 6 hours of detection, regardless of severity. This runs parallel to the DPDP Act's privacy-focused notification requirements. The combined framework creates overlapping obligations: CERT-In focuses on national cybersecurity and incident response, while the DPDP Act focuses on individual rights and organizational accountability.

Reportable incidents under CERT-In include data breaches, website defacements, malware infections, denial-of-service attacks, unauthorized access attempts, and credential compromises. Entities must maintain logs for 180 days and share them when directed. VPN providers, cloud operators, and data centres must retain subscriber KYC data for 5 years.

8.3 Gaps and Forward-Looking Analysis

The DPDP Act broadly anticipates the categories of breaches seen in 2025, but several gaps remain:

- **Third-Party/Vendor Risk:** The Act places primary accountability on Data Fiduciaries but provides limited prescriptive guidance on ensuring vendor cybersecurity, despite the banking S3 exposure demonstrating that third-party risk is the primary attack surface for many organizations.
- **'Reasonable Security Safeguards' Ambiguity:** The Act does not define specific technical standards, leaving 'reasonable' open to interpretation. This creates a gap where organizations can claim compliance without implementing effective controls.

- **Geopolitical/Hacktivist Threats:** The Act was designed primarily for commercial data protection, not for state-sponsored or geopolitically motivated attacks on critical infrastructure. The #OpIndia campaign exposed gaps in cross-sector coordination that fall outside the DPDP framework.
- **Enforcement Timeline:** The Data Protection Board of India is operational but still building adjudication capacity. Practical enforcement of penalty provisions remains untested.

Analysis: The DPDP Act, combined with CERT-In's 6-hour reporting mandate, creates a robust theoretical framework. However, the 2025 breaches demonstrate that legislative frameworks alone are insufficient without: (a) prescriptive technical standards, (b) mandatory third-party risk management, (c) active enforcement with meaningful penalties, and (d) integration with national security cyber operations.

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9. Technologies and Guidelines for Prevention

9.1 Zero Trust Architecture

Zero Trust Architecture (ZTA) has been consistently recommended by CERT-In, NIST, and global cybersecurity frameworks as the foundational security model for modern organizations. Its core principle, 'never trust, always verify,' directly addresses the identity-based and lateral-movement attack patterns that dominated 2025 breaches. Key ZTA components include micro-segmentation of networks, continuous identity verification, least-privilege access policies, and real-time monitoring of all access requests.

9.2 CERT-In 2025 Audit Guidelines

On July 25, 2025, CERT-In issued the Comprehensive Cyber Security Audit Policy Guidelines (CISG-2025-02), representing a fundamental shift from compliance-driven to resilience-driven security posture. Key mandates include: mandatory annual cybersecurity audits for all public and private enterprises aligned with ISO/IEC 27001; risk-based audit scoping; continuous monitoring and VAPT (Vulnerability Assessment and Penetration Testing); board-level visibility of audit outcomes; Software Bill of Materials (SBOM) requirements; and mandatory third-party vendor security assessments.

9.3 Technical Prevention Stack

Based on the vulnerabilities exploited in 2025, the following technical measures are recommended:

Layer	Technology/Measure	Addresses
Network	DDoS mitigation (CDN-based, on-prem scrubbing)	BSNL/President DDoS attacks
Network	IT-OT network segmentation	Power grid intrusion attempts
Identity	MFA everywhere + phishing-resistant (FIDO2/passkeys)	Credential leaks, phishing
Identity	Privileged Access Management (PAM)	Lateral movement, admin compromise
Cloud	Cloud Security Posture Management (CSPM)	S3 misconfigurations, IAM issues
Cloud	S3 bucket policy auditing + Block Public Access	Banking data exposure
Application	Web Application Firewall (WAF) + API gateway security	API exploits, injection attacks
Application	SAST/DAST in CI/CD pipelines	React2Shell, unpatched code
Endpoint	EDR/XDR with behavioral analytics	Ransomware (Hunters International)
Endpoint	Patch management (CVSS + EPSS prioritization)	Known CVE exploitation
Data	Data Loss Prevention (DLP) + encryption at rest/transit	Exfiltration prevention
Data	Database Activity Monitoring (DAM)	MongoDB, SQL injection attacks
Governance	SBOM management + vendor risk assessments	Third-party supply chain risk
Governance	Dark web monitoring + threat intelligence	Early breach detection (Angel One model)

10. Executable Code Snippets for Defensive Operations

The following code snippets are provided for security practitioners to implement defensive checks and monitoring. Each snippet is designed to be compiled and/or executed in its respective runtime environment.

10.1 AWS S3 Bucket Misconfiguration Scanner (Python)

This script uses the boto3 AWS SDK to scan all S3 buckets in an account for dangerous public access configurations, directly addressing the vulnerability pattern seen in the Nupay/banking exposure.

```
#!/usr/bin/env python3 """S3 Bucket Public Access Scanner - Detects misconfigured buckets.
Requires: pip install boto3 Usage: python s3_scanner.py Ensure AWS credentials are configured
(aws configure or env vars)."""  import boto3, json, sys from botocore.exceptions import
ClientError def scan_s3_buckets(): s3 = boto3.client('s3') findings = [] try: buckets =
s3.list_buckets()['Buckets'] except ClientError as e: print(f"[ERROR] Cannot list buckets:
{e}") sys.exit(1) for bucket in buckets: name = bucket['Name'] issues = [] # Check Block
Public Access settings try: pub = s3.get_public_access_block(Bucket=name) cfg =
pub['PublicAccessBlockConfiguration'] for key in ['BlockPublicAcls','IgnorePublicAcls',
'BlockPublicPolicy','RestrictPublicBuckets']: if not cfg.get(key, False):
issues.append(f"{key} is DISABLED") except ClientError: issues.append("No PublicAccessBlock
configured") # Check bucket ACL try: acl = s3.get_bucket_acl(Bucket=name) for grant in
acl.get('Grants', []): grantee = grant.get('Grantee', {}) uri = grantee.get('URI', '') if
'AllUsers' in uri or 'AuthenticatedUsers' in uri: issues.append(f"ACL grants to {uri}") except
ClientError: pass # Check bucket policy try: policy = json.loads(
s3.get_bucket_policy(Bucket=name)['Policy']) for stmt in policy.get('Statement', []):
principal = stmt.get('Principal', '') if principal == '*' and stmt.get('Effect') == 'Allow':
issues.append("Policy allows Principal: *") except ClientError: pass if issues:
findings.append({'bucket': name, 'issues': issues}) print(f"[ALERT] {name}:") for i in issues:
print(f" - {i}") else: print(f"[OK] {name}: Secure") print(f"\nScan complete. {len(findings)}
bucket(s) " f"with issues out of {len(buckets)}.") return findings if __name__ == '__main__':
scan_s3_buckets()
```

Listing 10.1: AWS S3 Bucket Misconfiguration Scanner (Python 3, requires boto3)

10.2 CERT-In 6-Hour Breach Notification Automator (Python)

This script provides a framework for automating breach notification workflows in compliance with CERT-In's 6-hour reporting mandate. It generates structured incident reports and tracks notification timelines.

```
#!/usr/bin/env python3 """CERT-In Breach Notification Framework. Generates structured
incident reports for 6-hour compliance. Usage: python breach_notifier.py""" import json,
hashlib, smtplib from datetime import datetime, timedelta from email.mime.text import MIMEText
class BreachNotifier: CERT_IN_EMAIL = "incident@cert-in.org.in" SIX_HOUR_WINDOW =
timedelta(hours=6) def __init__(self, org_name, cert_in_reg_id): self.org_name = org_name
self.reg_id = cert_in_reg_id self.incidents = [] def register_incident(self, incident_type,
description, affected_systems, data_categories, detection_time=None): detection =
detection_time or datetime.utcnow() deadline = detection + self.SIX_HOUR_WINDOW incident = {
"id": hashlib.sha256( f"{self.org_name}{detection.isoformat()}" .encode()).hexdigest()[:12],
"org": self.org_name, "reg_id": self.reg_id, "type": incident_type, "description":
description, "affected_systems": affected_systems, "data_categories": data_categories,
"detection_utc": detection.isoformat(), "deadline_utc": deadline.isoformat(), "status":
"DETECTED", "notifications_sent": [] } self.incidents.append(incident) remaining = (deadline
- datetime.utcnow()).total_seconds() print(f"[INCIDENT] {incident['id']} registered.")
print(f" Deadline: {deadline.isoformat()} UTC") print(f" Remaining: {remaining/3600:.1f}
hours") return incident def generate_cert_in_report(self, incident_id): inc = next((i for i in
self.incidents if i['id'] == incident_id), None) if not inc: raise ValueError(f"Incident
```

```
{incident_id} not found") report = { "reporting_entity": inc['org'], "cert_in_registration":
inc['reg_id'], "incident_id": inc['id'], "incident_category": inc['type'],
"detection_timestamp": inc['detection_utc'], "reporting_timestamp":
datetime.utcnow().isoformat(), "description": inc['description'], "affected_systems":
inc['affected_systems'], "data_categories_affected": inc['data_categories'],
"containment_actions": "Pending documentation", "iocs": "Pending analysis", "contact":
{"role": "CISO", "email": f"ciso@{inc['org'].lower()}.com"} } filename =
f"cert_in_report_{incident_id}.json" with open(filename, 'w') as f: json.dump(report, f,
indent=2) print(f"[REPORT] Generated: {filename}") return report # Example usage if __name__
== '__main__': notifier = BreachNotifier("ExampleCorp", "CERT-REG-12345") inc =
notifier.register_incident( incident_type="Unauthorized Access", description="Anomalous
access to cloud storage detected", affected_systems=["AWS S3", "Customer DB"],
data_categories=["PII", "Financial Records"] ) notifier.generate_cert_in_report(inc['id'])
```

Listing 10.2: CERT-In 6-Hour Breach Notification Automator (Python 3)

10.3 Known CVE Scanner (Bash)

This Bash script queries the NIST NVD API and CISA KEV catalog to check whether specific software versions are affected by known exploited vulnerabilities.

```
#!/bin/bash # Known CVE Scanner - Checks software against CISA KEV catalog # Usage: bash
cve_scanner.sh # Requires: curl, jq echo "=== Known Exploited Vulnerability Scanner ===" echo
"Checking against CISA KEV Catalog..." echo ""
KEV_URL="https://www.cisa.gov/sites/default/files/feeds/\
known_exploited_vulnerabilities.json" # Software inventory to check (customize for your
environment) declare -A SOFTWARE=( ["MongoDB"]="6.0" ["Apache Tomcat"]="9.0" ["Fortinet
FortiWeb"]="7.0" ["Citrix NetScaler"]="13.1" ["Palo Alto PAN-OS"]="10.2" ["React"]="19.0" ) #
Download KEV catalog KEV_FILE="/tmp/kev_catalog.json" curl -sS "$KEV_URL" -o "$KEV_FILE" if [
$? -ne 0 ]; then echo "[ERROR] Failed to download KEV catalog" exit 1 fi TOTAL=$(jq
'.vulnerabilities | length' "$KEV_FILE") echo "KEV catalog loaded: $TOTAL known exploited
CVEs" echo "" for product in "${!SOFTWARE[@]}"; do version="${SOFTWARE[$product]}" echo
"Checking: $product $version" matches=$(jq -r --arg p "$product" \ '.vulnerabilities[] |
select(.product | ascii_downcase | contains($p | ascii_downcase)) | " CVE: \(.cveID) |
\(.vulnerabilityName) | \ Due: \(.dueDate)"' "$KEV_FILE") if [ -n "$matches" ]; then echo
"[ALERT] Known exploited vulns found:" echo "$matches" else echo " [OK] No KEV matches (check
NVD for full list)" fi echo "" done echo "=== Scan Complete ===" echo "Note: This checks the
CISA KEV catalog only." echo "For comprehensive CVE lookup, query NVD API:" echo "
https://services.nvd.nist.gov/rest/json/cves/2.0"
```

Listing 10.3: CISA KEV Catalog Scanner (Bash, requires curl and jq)

10.4 DDoS Traffic Anomaly Detector (Python)

This script monitors network traffic patterns to detect DDoS indicators, specifically targeting the CLDAP, NTP, and NetBIOS reflection techniques used in the BSNL attacks.

```
#!/usr/bin/env python3 """DDoS Traffic Anomaly Detector. Monitors for
reflection/amplification attack indicators. Requires: pip install scapy (run as root/admin)
Usage: sudo python ddos_detector.py""" from collections import defaultdict from datetime
import datetime import time # Simulated packet analysis (replace with scapy capture in prod) #
In production, use: from scapy.all import sniff, IP, UDP class DDoSDetector: # Ports used in
reflection amplification attacks AMPLIFICATION_PORTS = { 389: "CLDAP", # Used in BSNL attack
Apr 23, 2025 123: "NTP", # Used in BSNL attack Apr 25-26, 2025 137: "NetBIOS", # Used in BSNL
attack Apr 25-26, 2025 53: "DNS", 1900: "SSDP", 11211: "Memcached" } THRESHOLD_PPS = 10000 #
Packets/sec threshold THRESHOLD_BPS = 1e9 # 1 Gbps threshold WINDOW_SECONDS = 10 def
__init__(self): self.packet_counts = defaultdict(int) self.byte_counts = defaultdict(int)
self.alerts = [] def analyze_packet(self, src_ip, dst_port, pkt_size): """Analyze single
packet for DDoS indicators.""" now = int(time.time()) // self.WINDOW_SECONDS key = (now,
dst_port) self.packet_counts[key] += 1 self.byte_counts[key] += pkt_size if dst_port in
```

```
self.AMPLIFICATION_PORTS: pps = self.packet_counts[key] / self.WINDOW_SECONDS bps =
(self.byte_counts[key]*8) / self.WINDOW_SECONDS if pps > self.THRESHOLD_PPS or bps >
self.THRESHOLD_BPS: protocol = self.AMPLIFICATION_PORTS[dst_port] alert = { "timestamp":
datetime.utcnow().isoformat(), "type": f"{protocol} Reflection Amplification", "port":
dst_port, "pps": int(pps), "gbps": round(bps / 1e9, 2), "severity": "CRITICAL" }
self.alerts.append(alert) print(f"[CRITICAL] DDoS DETECTED: " f"{protocol} amplification | "
f"Port {dst_port} | " f"{int(pps)} pps | " f"{round(bps/1e9,2)} Gbps") return alert return
None # Example / Test usage if __name__ == '__main__': detector = DDoSDetector() print("DDoS
Detector initialized. Monitoring ports:") for port, proto in
detector.AMPLIFICATION_PORTS.items(): print(f" Port {port}: {proto}") # Simulate traffic
spike on CLDAP port print("\nSimulating CLDAP reflection attack...") for i in range(15000):
detector.analyze_packet("203.0.113.1", 389, 4096) print(f"\nTotal alerts:
{len(detector.alerts)}")
```

Listing 10.4: DDoS Traffic Anomaly Detector (Python 3)

10.5 MongoDB Configuration Hardening Checker (Python)

This script checks MongoDB server configuration against security best practices, specifically addressing the MongoBleed vulnerability (CVE-2025-14847) and common misconfigurations found in Indian deployments.

```
#!/usr/bin/env python3 """MongoDB Security Configuration Checker. Checks for CVE-2025-14847
(MongoBleed) and common misconfigs. Requires: pip install pymongo Usage: python
mongo_checker.py --host localhost --port 27017""" import argparse, sys def
check_mongodb_security(host, port): try: from pymongo import MongoClient from pymongo.errors
import (ConnectionFailure, OperationFailure) except ImportError: print("[ERROR] Install
pymongo: pip install pymongo") sys.exit(1) findings = [] print(f"\n=== MongoDB Security Check:
{host}:{port} ===\n") # 1. Check if auth is required try: client = MongoClient(host, port,
serverSelectionTimeoutMS=5000) client.admin.command('ping') # If we get here without auth,
that's a problem try: dbs = client.list_database_names() findings.append({ "check":
"Authentication", "status": "CRITICAL", "detail": "Server accessible WITHOUT authentication.
" f"Databases exposed: {len(dbs)}" }) except OperationFailure: findings.append({ "check":
"Authentication", "status": "PASS", "detail": "Authentication required for operations" })
except ConnectionFailure: print(f"[ERROR] Cannot connect to {host}:{port}") sys.exit(1) # 2.
Check server version for CVE-2025-14847 try: info = client.server_info() version =
info.get('version', 'unknown') PATCHED = ['8.2.3','8.0.17','7.0.28','6.0.27','5.0.32']
major_minor = '.'.join(version.split('.')[:2]) is_patched = version in PATCHED
findings.append({ "check": "CVE-2025-14847 (MongoBleed)", "status": "PASS" if is_patched else
"WARNING", "detail": f"Version {version}. " f"{'Patched' if is_patched else 'Check patch
status'}" }) except Exception: pass # 3. Check network binding try: cmd_line =
client.admin.command('getCmdLineOpts') parsed = cmd_line.get('parsed', {}) net =
parsed.get('net', {}) bind_ip = net.get('bindIp', 'not set') if bind_ip in ['0.0.0.0', 'not
set']: findings.append({ "check": "Network Binding", "status": "CRITICAL", "detail":
f"bindIp={bind_ip}. Server listens on ALL " "interfaces. Restrict to localhost/specific IPs."
}) else: findings.append({ "check": "Network Binding", "status": "PASS", "detail":
f"bindIp={bind_ip}" }) # Check zlib compression (MongoBleed vector) compressors =
net.get('compression', {}).get( 'compressors', 'default') if 'zlib' in str(compressors) or
compressors == 'default': findings.append({ "check": "Zlib Compression (MongoBleed vector)",
"status": "WARNING", "detail": "zlib compression enabled (default). " "Consider disabling
until patched." }) except OperationFailure: pass # Print results for f in findings: icon =
{"PASS":"OK","WARNING":"WARN","CRITICAL":"ALERT"}
print(f"[{icon.get(f['status'],f['status'])}] " f"{f['check']}: {f['detail']}") critical =
sum(1 for f in findings if f['status']=='CRITICAL') warnings = sum(1 for f in findings if
f['status']=='WARNING') print(f"\n=== Results: {critical} critical, " f"{warnings} warnings
===") return findings if __name__ == '__main__': parser = argparse.ArgumentParser()
parser.add_argument('--host', default='localhost') parser.add_argument('--port', type=int,
default=27017) args = parser.parse_args() check_mongodb_security(args.host, args.port)
```

Listing 10.5: MongoDB Security Configuration Checker (Python 3, requires pymongo)

11. References and Vetted Sources

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12. Appendix: Glossary of Key Terms

Term	Definition
APT	Advanced Persistent Threat - a prolonged, targeted cyberattack by a well-resourced threat actor
CERT-In	Indian Computer Emergency Response Team, national nodal agency for cybersecurity under MeitY
CLDAP	Connection-less Lightweight Directory Access Protocol, commonly abused for DDoS amplification
CSPM	Cloud Security Posture Management - tools that identify and remediate cloud misconfigurations
CVSS	Common Vulnerability Scoring System - standardized severity rating for vulnerabilities
DDoS	Distributed Denial of Service - attack that overwhelms a target with traffic from multiple sources
DPDP Act	Digital Personal Data Protection Act, 2023 - India's comprehensive data protection legislation
DPB	Data Protection Board of India - adjudicatory body under the DPDP Act
EDR/XDR	Endpoint Detection and Response / Extended Detection and Response
EPSS	Exploit Prediction Scoring System - probabilistic model for predicting vulnerability exploitation
IAM	Identity and Access Management - framework for controlling user access to resources
IOC	Indicator of Compromise - forensic artifact suggesting a system has been breached
KEV	Known Exploited Vulnerabilities - CISA's catalog of vulnerabilities actively exploited in the wild
MFA	Multi-Factor Authentication - requiring two or more verification methods
NACH	National Automated Clearing House - RBI system for high-volume electronic transactions
NTP	Network Time Protocol - used legitimately for time sync, abused for DDoS amplification
OT	Operational Technology - hardware/software monitoring and controlling physical processes
RaaS	Ransomware-as-a-Service - business model where ransomware tools are leased to affiliates
RAT	Remote Access Trojan - malware providing covert remote control of compromised systems
S3	Amazon Simple Storage Service - cloud object storage service
SBOM	Software Bill of Materials - inventory of all components in a software product
VAPT	Vulnerability Assessment and Penetration Testing
ZTA	Zero Trust Architecture - security model assuming no implicit trust for any entity

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