Predictive Network Maintenance: How AI Forecasts System Failures

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Introduction

- Network reliability always been a critical concern.
- Various protocols and technologies developed
  - based on reactive approaches
  - require a failure to happen first before mitigation.
- Networks growing in complexity – creating demand for proactive predictions

- Predictive Network Maintenance aim to reroute or repair systems in anticipation of failure, a major shift from traditional reactive approaches.

Network Failures

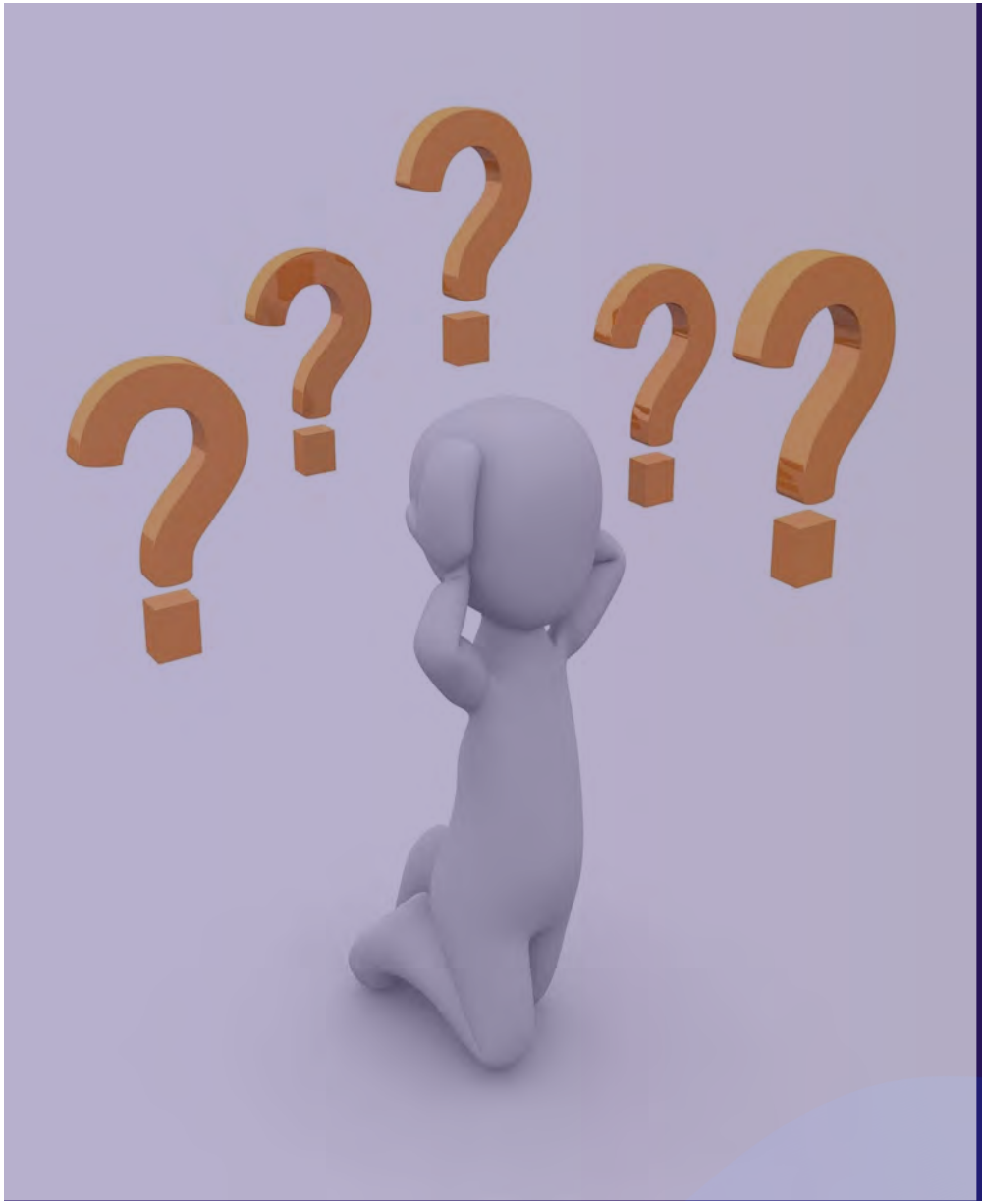
Complete or partial failure of hardware or software components in a network causing service disruption for end users

Causes

- link failures (fiber cut, configuration error)
- software bugs, which refer to glitches caused due to upgrades etc
- Misconfiguration or human errors
- Hardware failures
- and even cyberattacks

Cost

- Average cost of network downtime ~$5,600 per minute (Gartner)
- Globally for telecom operators, the annual cost can exceed $60 billion



Problem with Current Network Maintenance

Traditional fault management capabilities are reactive and do not have ability to learn from faults, leading to:

- Unexpected downtimes.
- High operational costs.
- Inefficiencies.
- Major SLA delays
- Grey Failures

Why Predictive Network Maintenance?

- The complexity and diversity of today's networks require
  - proactive approaches.
  - better accuracy in fault detection
  - scalable solutions to keep up with network demands
  - an ability to learn

Predictive networks detect subtle signs of disruption, minimizing downtime, improving cost and optimizing performance.

Towards Predictive Networks

1. **Define the problem**

2. **Collect Data**
   - Historical records of faults, causes etc
   - Real-time data collected through continuous monitoring of networks
     - Packet logs
     - Network alarms
     - Flow telemetry data
     - Packet traces
     - Device configurations
     - Network topology

3. **Prep the data – features extraction**
   - Extract data on packet/flow/application level based on KPI
   - For fault detection typically network alarms, packets loss, jitter, packet errors, latency

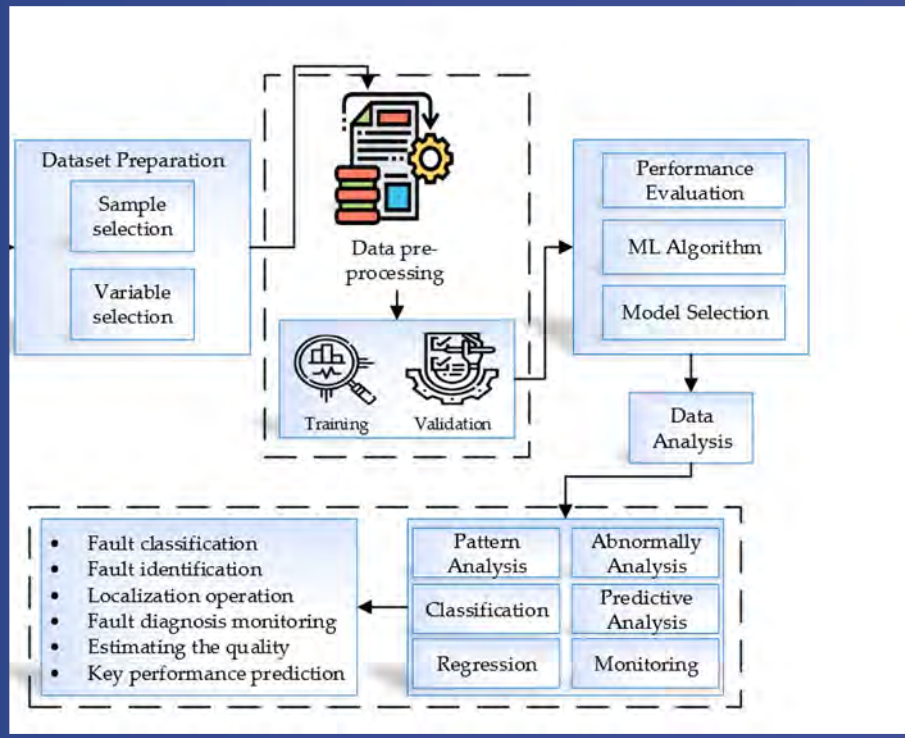
Predicting Faults

Fault Prediction Model Development

- No "Best" Algorithm: Effective models include LSTM, Decision Trees, and Random Forests
- Hybrid Learning: Combining supervised and unsupervised learning enhances fault detection.

Model Evaluation & Optimization

- Accuracy: Balance false positives, false negatives, and true positives.
- Minimize False Positives: Reduces unnecessary actions that may disrupt service.
- Accept Imperfections: Focus on reducing critical faults rather than predicting all.



Predictive Networks: Outcome

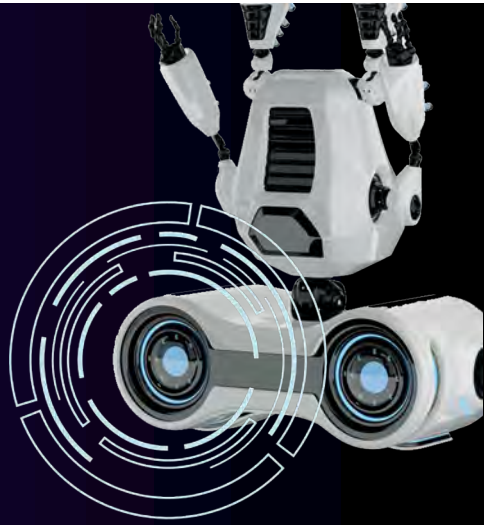
Prediction accuracy: Most case studies done report > 98% performance (F1 score) in failure predictions for large datasets

Reduced downtime: Studies show that predictive maintenance can reduce downtime by upto 50%

Cost Savings : Reduced maintenance costs by 30-40%

Root Cause analysis : Insights into underlying issue.

Challenges in Predictive Maintenance



- Collecting right data
- Collecting the right features (feature engineering)
- Determining the most suitable machine learning technique
- How to enable machine learning models to learn consistently across non-uniform networks

The Future of Network Maintenance

Autonomic self-healing networks represent the next step in network reliability

Self-Monitoring: Sensors continually track network health and performance.

Automated Fault Detection: Identifies anomalies or potential failures as they arise.

Real-Time Response: Uses pre-set rules and AI-driven decisions to reconfigure and repair within real time (few seconds)

Reduced Downtime: Minimizes the impact of faults by responding instantly.

Enhanced Resilience: Adapts to dynamic conditions, sustaining high reliability with minimal human input

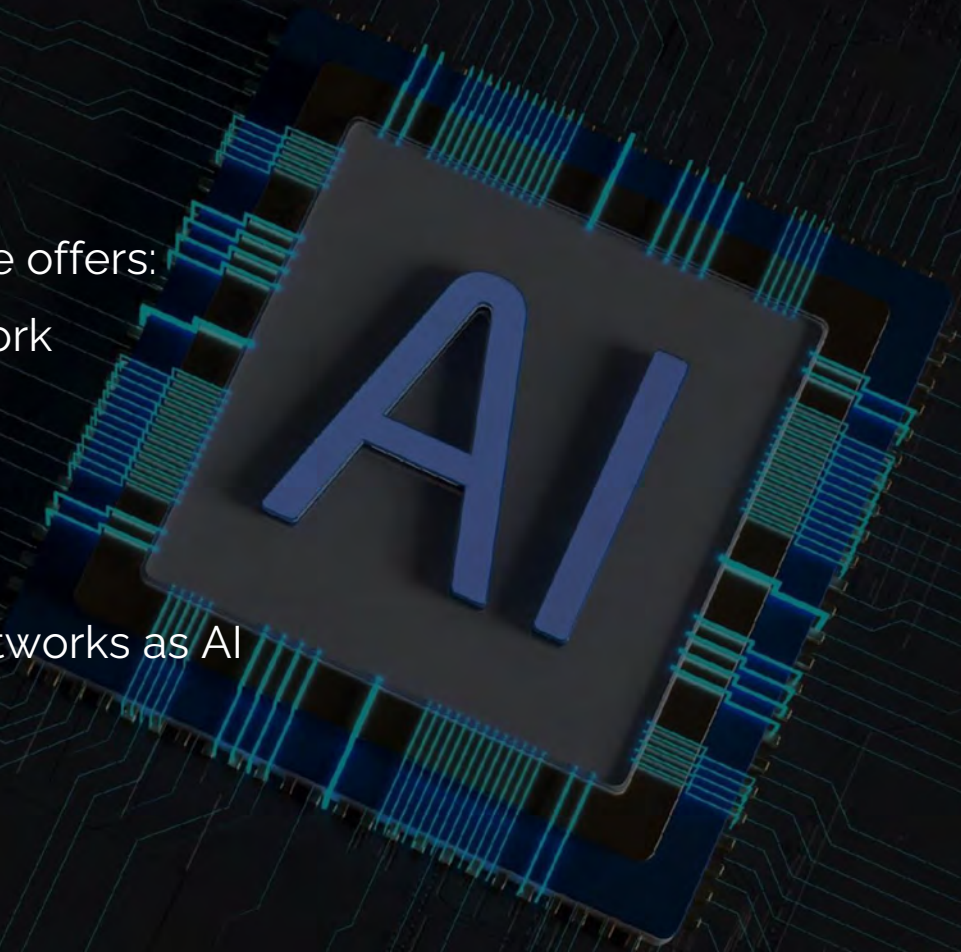
Reactive vs Predictive

- Complementary
- Reactive still has role to play

Key Takeaways

AI-driven predictive network maintenance offers:

- A proactive, reliable approach to network management.
- Significant reductions in downtime.
- Optimized operations.
- Potential for smarter, more resilient networks as AI evolves.




Thank You