THE ESSENTIAL GUIDE TO MACHINE DATA

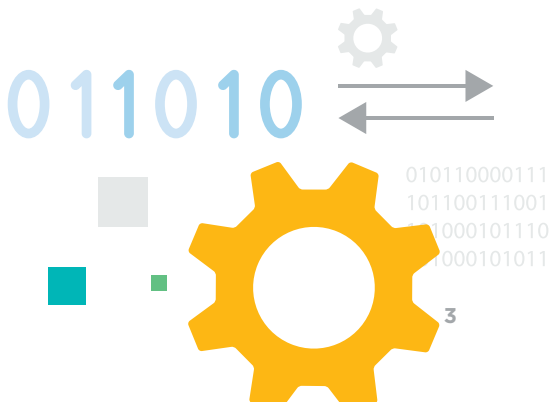
DIGITAL EXHAUST. TIME-SERIES DATA. BIG DATA.

Whatever you call it, machine data is one of the most underused and undervalued assets of any organization. And, unfortunately, it's usually kept for some minimum amount of time before being tossed out and never looked at again.

But some of the most important insights you can gain—across IT and the business—are hidden in this data: where things went wrong, how to optimize the customer experience, the fingerprints of fraud. All of these insights can be found in the machine data generated by the normal operations of your organization.

Machine data is valuable because it contains a definitive record of all the activity and behavior of your customers, users, transactions, applications, servers, networks and mobile devices. It includes configurations, data from APIs, message queues, change events, the output of diagnostic commands, call detail records and sensor data from industrial systems and more.

The challenge with leveraging machine data is that it comes in a dizzying array of unpredictable formats, and traditional monitoring and analysis tools weren't designed for the variety, velocity, volume or variability of this data. But there's a tremendous upside for organizations that take advantage of this data—including quickly diagnosing service problems, detecting sophisticated security threats, understanding the health and performance of remote equipment and demonstrating compliance.



USING MACHINE DATA IN PRACTICE

Using machine data requires three (seemingly) simple steps:

The organizations that get the most value from machine data are able to take disparate data types, link them together, and gain value from the result. But one of the biggest challenges is understanding what data you should ingest.

By defining the use cases you're attempting to resolve – be it security, IT operations, business analytics or the Internet of Things – you can start to identify the data sources you should ingest and begin correlating.

So how does machine data provide value? See the example to the right.

In this example, analyzing the machine data makes the story clear:

1. A customer's order didn't go through
2. The customer called Support to try to resolve the issue
3. After some time on hold, the customer sent a negative tweet about the company

By linking together the machine data, the company can see the original issue and get a full view of the customer experience.

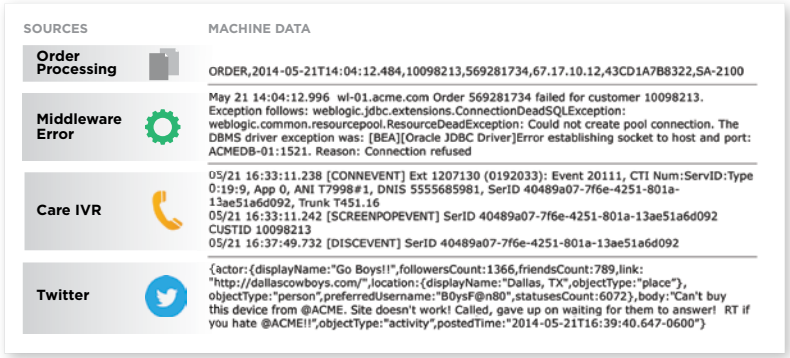


Figure 1: Machine data can come from any number of sources, and at first glance, can look like random text.

Figure 2: The value of machine data is hidden in this text.

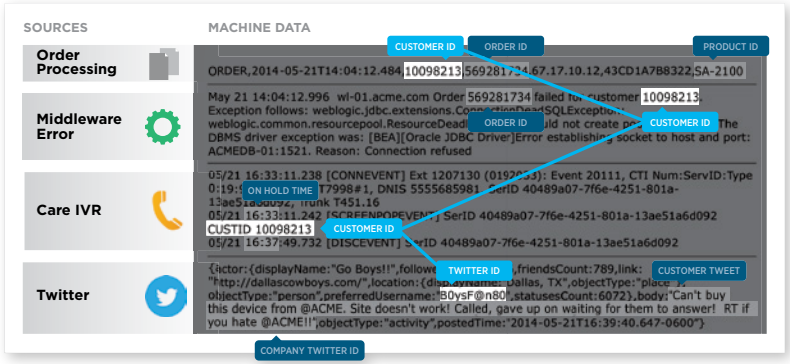


Figure 3: By correlating different types of machine data together, you can start to gain real insight into what's going on in your infrastructure, see security threats or even use the insights to drive better business decisions.

THE ESSENTIAL GUIDE TO MACHINE DATA

This book provides a high-level overview of the most common types of machine data that are found in organizations of nearly any size. While each organization's needs and data sources will vary by vendor, product and infrastructure, this book details where you should look for machine data and the value it can provide to IT, security, business analytics and Internet of Things use cases.

Many of the data sources listed in this book can support multiple use cases – this is a major part of what drives machine data's tremendous value. The use cases supported by each data source can be easily identified with the icons below.

SECURITY & COMPLIANCE

IT OPS, APP DELIVERY & DEVOPS

INTERNET OF THINGS

BUSINESS ANALYTICS

Table of Contents

User Data **8**
- Authentication 8
- Virtual Private Networks (VPN) 10

Application Data **12**
- Antivirus 12
- (APM) Tool Logs 14
- Custom Application Logs & Debug Logs 16
- CRM, ERP and Other Business Applications 18
- Code Management 20
- Vulnerability Scanning 22
- Mail Server 24
- Test Coverage Tools 26
- Automation, Configuration and Deployment Tools (Platforms) 28
- Build Systems (Platforms) 30
- Binary Repositories 32
- Container Logs & Metrics 34

Middleware Data **36**
- Middleware 36
- Web Server 38
- Application Server 42
- Mobile Device Data 44

Network Data **46**
- SNMP 46
- Deep Packet Inspection Data 48
- DHCP 50
- Endpoint 52
- Firewall 54
- FTP 56
- Intrusion Detection/Prevention 58
- Load Balancer 60
- DNS 62
- Network Access Control (NAC) 64
- Network Switches 66
- Network Routers 68
- Network Protocols 70
- Proxies 72
- VoIP 74

Operating System Data **76**
- System Logs 76
- System Performance 78

Virtual Infrastructure Data **80**
- Amazon Web Services (AWS) 80
- Microsoft Azure 82
- VMware Server Logs, Configuration Data and Performance Metrics 84

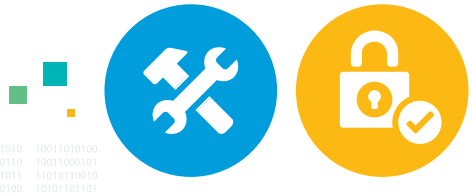
Physical Infrastructure & IoT Data **86**
- Physical Card Readers 86
- Sensor Data 88
- Server Logs 90
- Backup 92
- Storage 94
- Mainframe 96
- Patch Logs 98
- Telephony 100
- Point of Sale Systems 102
- RFID/NFC/BLE 104
- Smart Meters 106
- Transportation 108
- Medical Devices 110
- Environmental Sensors 112
- Industrial Control Systems 114
- Wearables 116

Additional Data Sources **118**
- Database 118
- Third-Party Lists 120
- Social Media Feeds 122
- Human Resources 124
- Business Service Transaction & Business Service Performance Data 126

AUTHENTICATION DATA

Use Cases: Security & Compliance, IT Operations, Application Delivery
Examples: Active Directory, LDAP, Identity Management, Single-Sign On

USER DATA



Authentication data provides insight into users and identity activity. Common authentication data sources include:

- **Active Directory:** a distributed directory in which organizations define user and group identities, security policies and content controls.
- **LDAP:** an open standard defined by the IETF and is typically used to provide user authentication (name and password). It has a flexible directory structure that can be used for a variety of information such as full name, phone numbers, email and physical addresses, organizational units, workgroup and manager.
- **Identity Management:** identity management is the method of linking the users of digital resources—whether people, IoT devices, systems or applications—to a verifiable online ID.
- **Single Sign-On (SSO):** a process of using federated identity management to provide verifiable, attestable identities from a single source to multiple systems. SSO significantly increases security by tying user credentials to a single source, allowing changes to user rights and account status to be made once, and reflected in every application or service to which the user has access. SSO is particularly important for users with elevated security rights such as system or network administrators that have access to a large number of systems.

Use Cases:

IT Ops & Application Delivery: Authentication data supports IT operations teams as they troubleshoot issues related to authentication. For example, application support can be tied to logins, enabling IT operations to see whether users are struggling to log in to applications. For IT operations teams that support Active Directory, logs can be used to troubleshoot and understand the health of Active Directory.

Security & Compliance: For security, authentication data provides a wealth of information about user activity, such as multiple login failures or successes to multiple hosts in a given time window, activities from different locations within a given amount of time, and brute force activities. Specifically:

- Active Directory domain controller logs contain information regarding user accounts, such as privileged account activity, as well as the details on remote access, new account creation and expired account activity.
- LDAP logs include a record of who, when and where users log in to a system and how information is accessed.
- Identity Management data shows access rights by user, group and job title (e.g., CEO, supervisor or regular user). This data can be used to identify access anomalies that could be potential threats—for example, the CEO accessing a low-level networking device or a network admin accessing the CEO's account.

VIRTUAL PRIVATE NETWORKS (VPN)

Use Cases: Security & Compliance
Examples: Citrix NetScaler Nitro, Citrix NetScaler IPFIX, Cisco

Virtual private networks (VPNs) are a way of building a secure extension of a private network over an insecure, public one. VPNs can be established either between networks, routing all traffic between two sites, or between a client device and a network. Network-to-network VPNs typically are created using strong credentials such as certificates on each end of the connection. Client-to-network VPNs rely on user authentication, which can be as simple as a username and password. VPNs use network tunneling protocols such as IPSec, OpenVPN plus SSL or L2TP with cryptographically strong algorithms to scramble information in transit and ensure end-to-end data integrity.

Use Cases:

Security & Compliance: VPN logs help in analyzing users coming onto the network. This information can be used in a number of ways, including situational awareness, monitoring foreign IP subnets, and compliance monitoring of browsers and applications of connected hosts. VPN data can also help identify:

- Activities from different locations, such as changes in location within a given amount of time
- Access from risky countries or locations
- User sessions at odd times, such as late evenings or weekends
- User land speed violations
- Abnormal frequency of sessions based on each user profile

ANTIVIRUS

Use Cases: Security & Compliance
Examples: Kaspersky, McAfee, Norton Security, F-Secure, Avira, Panda, Trend Micro

The weakest link in corporate security is an individual, and antivirus is one way to protect employees from performing inadvertently harmful actions. Whether it's clicking on an untrustworthy web link, downloading malicious software or opening a booby-trapped document (often one sent to them by an unsuspecting colleague), antivirus can often prevent, mitigate or reverse the damage.

So-called advanced persistent threats (APTs) often enter through a single compromised machine attached to a trusted network. While not perfect, antivirus software can recognize and thwart common attack methods before they can spread.

Use Cases:

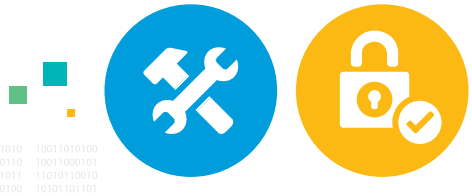
Security & Compliance: Antivirus logs support the analysis of malware and vulnerabilities of hosts, laptops and servers; and can be used to monitor for suspicious file paths. This data can help identify:

- Newly detected binaries, file hash, files in the filesystem and registries
- When binaries, hash or registries match threat intelligence
- Unpatched operating systems
- Known malware signatures

APM TOOL LOGS

Use Cases: IT Operations, Application Delivery, Security & Compliance
Examples: Dynatrace, New Relic, App Dynamics, MMSoft Pulseway, LogicMonitor, Stackify, Idera, Ipswitch

APPLICATION DATA



Application Performance Management (APM) software provides end-to-end measurement of complex, multi-tier applications to provide performance metrics from an end user's perspective. APM logs also provide event traces and diagnostic data that can assist developers in identifying performance bottlenecks or error conditions. The data from APM software provides both a baseline of typical application performance and a record of anomalous behavior or performance degradation. Carefully monitoring APM logs can provide an early warning to application problems and allow IT and developers to remediate issues before users experience significant degradation or disruption. APM logs also are required to perform post-hoc forensic analysis of complex application problems that may involve subtle interactions between multiple machines, network devices or both.

Use Cases:

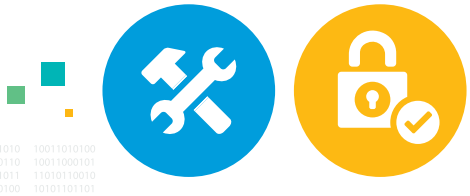
IT Ops & Application Delivery: By providing end-to-end measurement of complex, multi-tier applications, APM logs can show infrastructure problems and bottlenecks that aren't visible when looking at each system individually, such as slow DNS resolution causing a complex web app to bog down as it tries to access content and modules on many different systems.

Security & Compliance: Security teams can use APM logs to perform post-hoc forensic analysis of incidents that span multiple systems and exploit vulnerabilities. The data can be used to correlate security indications between the system and application activities. It also helps to identify SQL/API calls/CMD made in relation to suspicious activity, or abnormal amounts of sessions or CPU load in relation to security activity.

CUSTOM APPLICATION & DEBUG LOGS

Use Cases: IT Operations, Application Delivery, Security & Compliance
Examples: Custom applications

APPLICATION DATA



Best practices for application developers require the inclusion of debugging code in applications that can be enabled to provide minute details of application state, variables and error conditions or exceptions. Debug output is typically logged for later analysis that can expose the cause of application crashes, memory leaks, performance degradation and security holes. Furthermore, since the events causing a security or performance problem may be spaced over time, logs—along with the problem software—can help correlate and trace temporally separated errors to show how they contribute to a larger problem.

Application debug logs provide a record of program behavior that is necessary to identify and fix software defects, security vulnerabilities or performance bottlenecks. While test logs record the output results of application usage, debug logs provide information about an application's internal state, including the contents of variables, memory buffers and registers; a detailed record of API calls; and even a step-by-step trace through a particular module or subroutine. Due to the performance overhead and amount of data produced, debug logs typically are enabled only when a problem can't be identified via test or event logs.

Use Cases:

IT Ops & Application Delivery: Debug output can expose application behavior that causes inefficient use of system resources or application failures that can be addressed by developers and operations teams. Debug output is useful for unraveling the internal state of an application that exhibits performance problems or has been shown to have security vulnerabilities, and the data can be helpful in identifying root cause

Security & Compliance: Security breaches are often the result of improper handling of unexpected inputs, such as buffer overflow exploits or data injection used in cross-site scripting attacks. This type of low-level vulnerability is almost impossible to detect without logging the internal state of various application variables and buffers.

Similar to APM logs, custom application and debug logs can be used to correlate security indications between the system and application activities. It also helps to identify SQL/API calls/CMD made in relation to suspicious activity, or abnormal amounts of sessions or CPU load in relation to security activity.

CRM, ERP AND OTHER BUSINESS APPLICATIONS

Use Cases: Application Delivery, Security & Compliance, Business Analytics, IoT
Examples: SAP, SFDC, SugarCRM, Oracle, Microsoft Dynamics

Business Applications can create a wealth of data as part of normal operations. Two examples are CRM and ERP applications:

- **Customer relationship management (CRM)** systems have become an essential part of every organization, providing a central database of all customer contact information, communications and transaction details. CRM systems have evolved from simple contact management systems to platforms for customer support and engagement by providing personalized sales and support information. The same customer support data repository can be used to develop customized marketing messages and sales promotions. CRM systems are also useful for application support and enhancement by recording details about customer problems with a particular system or application along with their eventual solution—details that can inform future application or service updates.

- **Enterprise resource planning (ERP)** applications are a critical back-office IT service that provides systematic, automated collection and analysis of a variety of product, supply chain and logistics data. ERP is used in product planning, tracking purchases of components and supplies, inventory management, monitoring and regulating manufacturing processes, managing logistics, warehouse inventory and shipping and to monitor and measure the effectiveness of sales and marketing campaigns. ERP software also integrates with CRM, HR, finance/accounting/payroll and asset management systems, with bidirectional data flows that provide consistent information across back-end digital business processes. ERP systems are typically built on a relational database management system with a variety of modules and customizations for specific functions such as supplier relationship management or supply chain management. Due to their complexity, ERP systems often are installed and managed by product specialists.

Use Cases:

Application Delivery: CRM databases can provide a complete record of all information and events leading up to a customer escalation. When combined with other data sources, CRM can provide indicators of deeper issues.

Like other application records, ERP logs are necessary when debugging performance and reliability problems due to the complex interactions between many systems in an ERP implementation. Logs are also useful in capacity planning.

Security & Compliance: CRM records can help security teams unravel incidents that involve multiple customers and problem episodes over a long time span. They can also provide evidence of a breach, should records be modified outside normal business processes. In addition, the data can be used to audit access records of customer or internal user information.

Business Analytics & IoT: CRM and ERP data is a crucial source of referential and transactional data that helps drive much needed context to machine data in business use cases. For instance, when combined with point-of-sale data and mobile application data from loyalty applications, retailers can drive real-time 1:1 targeted marketing campaigns, and then use machine learning to predict customer purchasing behavior and revenue trends.

CODE MANAGEMENT

Use Cases: Application Delivery

APPLICATION DATA

For all but the most trivial implementations, application source code is comprised of dozens if not hundreds of interrelated files. The complexity and volatility of code—particularly when using agile development methodologies and changes are made daily—makes keeping track of it virtually impossible without a structured, automated source code management and revision control system.

Originally built as client-server applications where developers checked in code to a central repository, today's systems (such as Git) are often distributed, with each developer working from a local copy of the full repository and changes synchronized across all subscribers to a particular project. Code management systems provide revision control (the ability to back out changes to an earlier version), software build automation, configuration status records and reporting, and the ability to branch or fork all or part of a source-code tree into a separate subproject with its own versioning.

Use Cases:

Application Delivery: The version records of code management can help IT operations teams identify application changes that are causing system problems, such as excessive resource consumption or interference with other applications.

VULNERABILITY SCANNING

Use Cases: Security & Compliance
Examples: ncircle IP360, Nessus

APPLICATION DATA

An effective way to find security holes is to examine infrastructure from the attacker's point of view. Vulnerability scans probe an organization's network for known software defects that provide entry points for external agents. These scans yield data about open ports and IP addresses that can be used by malicious agents to gain entry to a particular system or entire network.

Systems often keep network services running by default, even when they aren't required for a particular server. These running, unmonitored services are a common means of external attack, as they may not be patched with the latest OS security updates. Broadscale vulnerability scans can reveal security holes that could be leveraged to access an entire enterprise network.

Use Cases:

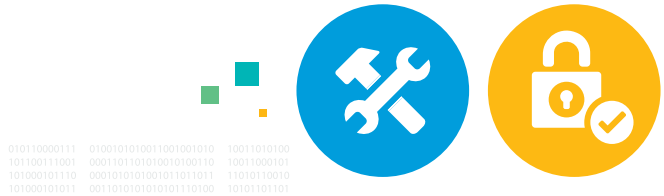
Security & Compliance: Vulnerability scans yield data about open ports and IP addresses that can be used by malicious agents to gain entry to a particular system or entire network. The data can used to identify:

- System misconfiguration causing security vulnerability
- Outdated patches
- Unnecessary network service ports
- Misconfigured filesystems, users or applications
- Changes in system configuration
- Changes in various user, app or filesystem permissions

MAIL SERVER

Use Cases: IT Operations, Security & Compliance
Examples: Exchange, Office 365

APPLICATION DATA



Email remains the primary form of formal communication in most organizations. As such, mail server databases and logs are some of the most important business records. Due to their size and tendency to grow without bounds, email data management typically requires both data retention and archival policies so that only important records are held and inactive data is moved to low-cost storage.

Use Cases:

IT Ops: Email messages and activity logs can be required to maintain compliance with an organization's information security, retention and regulatory compliance processes. Mail server transaction and error logs also are essential debugging tools for IT problem resolution and also may be used for usage-based billing.

Security & Compliance: Mail server data can help identify malicious attachments, malicious domain links and redirects, emails from known malicious domains, and emails from unknown domains. It can also be used to identify emails with abnormal or excessive message sizes, and abnormal email activities times.

TEST COVERAGE TOOLS

Use Cases: Application Delivery & DevOps
Examples: Static Analysis & Unit Testing logs (SonarQube, Tox, PyTest, RubyGem MiniTest, Bacon, Go Testing), build server logs and performance metrics

Typical test coverage includes functional, statement, branch and conditional coverage. The idea is to match what percentage of code can be exercised by a test suite of one or more coverage criteria. Coverage tests are usually defined by rule or requirements. In addition to coverage testing, software delivery teams can utilize machine data to understand the line count, code density and technical debt.

Use Cases:

Application Delivery and DevOps: Test coverage data monitoring helps release managers, application owners and others understand:

- How much technical debt and issues are they resolving?
- How ready is their next release?
- From unit testing – how many tests were performed per hour and what tests are being run?

If test coverage data is combined with build data, release managers can start monitoring build and release performance and start understanding the release quality. They can understand the trends in error percentage and make decisions on if the build is ready for production. Understanding code quality can also help support teams get prepared for any additional volume of calls or any particular issues that may arise.

AUTOMATION, CONFIGURATION, DEPLOYMENT TOOLS (PLATFORMS)

Use Cases: Application Delivery & DevOps
Examples: Puppet Enterprise, Ansible Tower, Chef, SaltStack, Rundeck, machine data ingested through APIs, webhooks or run logs

APPLICATION DATA

Automated configuration and deployment tools, also known as “infrastructure as code,” allow IT and DevOps practitioners to practice continuous application delivery in the cloud or on premises. When infrastructure is treated as code, it’s easy to share, collaborate, manage version control, perform peer unit testing, automate deployments, check the status of deployment and more.

Tools like Rundeck are platforms that take automation frameworks like Salt Stack and enable teams to automate states or playbook to make sure the code is released and reported back to a central reporting tool.

Use Cases:

Application Delivery: Automation and configuration machine data monitoring helps application delivery teams deliver applications faster without sacrificing stability or security.

BUILD SYSTEMS (PLATFORMS)

Use Cases: Application Delivery & DevOps
Examples: Jenkins, Bamboo, TravicCI, TeamCity, machine data ingested through APIs, logs, webhooks

APPLICATION DATA

Build platforms, like Jenkins and Bamboo, enable a continuous integration practice that allows application delivery teams—including developers, DevOps practitioners, QA, and release engineering—to build artifacts, trigger new builds and environments, automate tests and more.

Use Cases:

Application Delivery and DevOps: Build systems monitoring helps release managers, test and QA teams understand the health of their build environment, the status of tests, get insights into stack traces and build queues. This visibility helps remediate build or test bottlenecks and increase the application delivery velocity and quality.

BINARY REPOSITORIES

Use Cases: Application Delivery & DevOps
Examples: Data from Nexus, Artifactory, delivered through APIs, webhooks; Yum, Pacman and Aptly data delivered through logs

APPLICATION DATA

A binary repository is a tool for downloading and storing of binary files used and created in software development. It's used to store software binary packages, artifacts and their corresponding metadata. They're different than source code repositories, as binary repositories do not store source files. Searching through these repositories is possible by analyzing associated metadata.

Use Cases:

Application Delivery and DevOps: Analyzing binary repository data helps application delivery teams and release managers to ensure that the final deployment of code to production is successful.

CONTAINER LOGS AND METRICS

Use Cases: Application Delivery & DevOps
Examples: Docker

APPLICATION DATA

Container logs are an efficient way to acquire logs generated by applications running inside a container. By utilizing logging drivers, output that is usually logged is redirected to another target. Since logging drivers start and stop when containers start and stop, this is the most effective way of capturing machine data, given the often limited lifespan of a container.

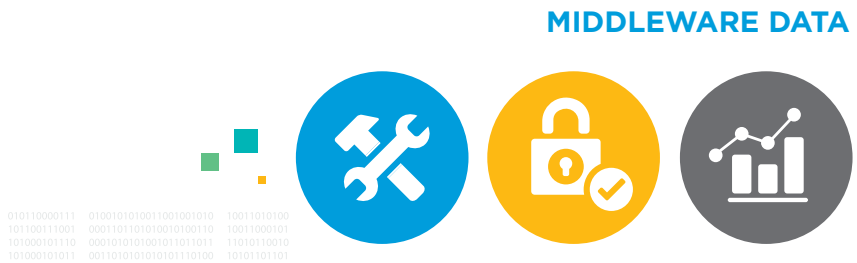
Container metrics contain details related to CPU, memory, I/O and network metrics generated by a container. By capturing this data, you have the opportunity to spot specific containers that appear to consume more resources than others – enabling faster, more precise troubleshooting.

Use Cases:

Application Delivery and DevOps: Acquiring container log files gives developers and operations teams insight on errors, issues and availability of applications running inside containers. Logs and metrics at the container level also call attention to containers whose performance is outside of expected parameters. As a result, admins can “kill” or “stop” a container instance and “run” a new container in its place.

MIDDLEWARE

Use Cases: IT Operations, Application Delivery, Security & Compliance, Business Analytics
Examples: Tibco, Software AG



Middleware describes a software layer of the prototypical three-tier enterprise application that typically implements data transformations, analysis and business logic. Middleware accesses databases for persistent storage and relies on web apps for the user interface. Middleware is often developed on the J2EE platform.

Use Cases:

IT Ops & Application Delivery: Middleware data can help operations teams diagnose problems with three-tier applications that involve the interaction between web, middleware and database servers.

Security & Compliance: Since middleware generally accesses network services and sensitive databases, security teams can use log data to vet application integrity, identify suspicious behavior and specific vulnerabilities. It can also be used for user and customer transaction monitoring and to identify abnormal transactions, unknown user interaction with third party accounts, and the sequence of exact transaction patterns that match known fraudulent profiles.

Business Analytics: Middleware messaging data is crucial to understanding transactional business process execution. Using this data can lead to a better understanding of the overall performance of a business process, bottlenecks and the opportunities of process improvement, as well as real-time reaction to potential failures. When used with machine learning, this data can help predict problems in a process or provide early indication to where a process is failing.

WEB SERVER

Use Cases: IT Operations, Application Delivery, Security & Compliance, Business Analytics
Examples: Java J2EE, Apache, Application Usage Logs, IIS logs, nginx

Web servers are the backend application behind every website that delivers all content seen by browser clients. Web servers access static HTML pages and run application scripts in a variety of languages that generate dynamic content and call other applications such as middleware.

Web servers can vary widely, and can include:

- **Java – J2EE:** Java is the most popular programming language due to its versatility, relative ease of use and rich ecosystem of developer tools. Via the J2EE platform, which includes APIs, protocols, SDKs and object modules, Java is widely used for enterprise apps including web applets, middle-tier business logic and graphic front ends. Java is also used for native Android mobile apps.
- **Apache:** Apache is one of the oldest and most-used web servers on the internet, powering millions of enterprise, government and public sites. Apache keeps detailed records of every transaction: every time a browser requests a webpage, Apache log details include items such as the time, remote IP address, browser type and page requested. Apache also logs various error conditions such as a request for a missing file, attempts to access a file without appropriate permissions or problems with an Apache plug-in module. Apache logs are critical in debugging both web application and server problems, but are also used to generate traffic statistics, track user behavior and flag security attacks such as attempted unauthorized entry or DDoS.
- **Application Usage Logs:** Like Apache web logs, collecting application usage logs can provide valuable information to multiple stakeholders including developers, IT, sales and marketing. Depending on how granular the measurement, usage tracking can assist developers in identifying application features that are most and seldom used, those that users have trouble with and areas for future enhancement. For customer-facing applications, usage logs provide sales and marketing teams insight into the effectiveness of online and app-based sales channels and promotions, data about sell-through and transaction abandonment, and information for potential cross-sales promotions.

Use Cases:

IT Ops & Application Delivery: Web logs are critical in debugging both web application and server problems, but also are used to generate traffic statistics that are useful in capacity planning. Web server data can provide varying information for IT operations teams:

- J2EE data can help operations teams diagnose problems with three-tier applications that involve the interaction between web, middleware and database servers.
- In aggregate, Apache web logs can show activity of a web service. Drilling into details can reveal infrastructure bottlenecks and indicate downstream issues.

WEB SERVER
(Continued)

- Application usage logs can help IT operations teams with infrastructure capacity planning, optimization, load balancing and usage-based billing by providing detailed records of resource consumption.

Security & Compliance: Web logs record error conditions such as a request to access a file without appropriate permissions and also track user activity that can flag security attacks such as attempted unauthorized entry or DDoS. It can also help to identify SQL injections and support correlating fraudulent transactions.

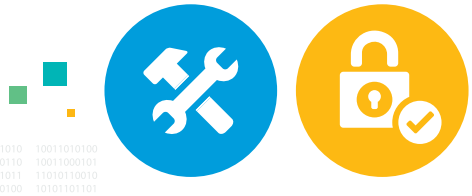
- Since Java apps frequently access network services and sensitive databases, security teams can use log data to vet the integrity of J2EE apps, identify suspicious application behavior and application vulnerabilities.
- Apache web logs can alert to security attacks such as attempted unauthorized entry, XSS, buffer overflows or DDoS.
- Like web logs, generic application usage logs can alert security teams to unauthorized access such as a someone consuming more resources than normal, or using applications at odd hours.

Business Analytics: Web logs are crucial to understanding the interaction between a company's customers and the overall journey they're taking across multiple channels of the business. This data can help companies understand what customers are looking for, where they are spending time, or what they were looking for before they called your call center for help. When correlated with CRM and point-of-sale data, companies can gain a better overall understanding of customer journeys, driving higher conversions from browse to act, and act to purchase.

APPLICATION SERVER

Use Cases: IT Operations, Application Delivery, Security & Compliance
Examples: log4j, log4php

MIDDLEWARE DATA



Whether building a multi-tier web application or using a traditional client-server design, application servers run the backend software that handles user requests. Today, these are typically deployed as virtual machines on a multi-tenant hypervisor.

Use Cases:

IT Ops & Application Delivery: The value of application server logs depends on what they collect; however, these may include customer information useful in troubleshooting or application state transitions similar to, but less verbose than debug output that can provide clues to application crashes, memory leaks and performance problems.

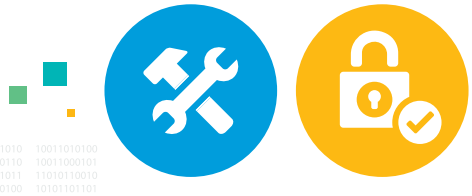
Security & Compliance: Security breaches are often the result of improper handling of unexpected inputs, such as buffer overflow exploits or data injection used in cross-site scripting attacks. This type of low-level vulnerability is almost impossible to detect without logging the internal state of various application variables and buffers. Since the events causing a security or performance problem may be spaced over time, logs, along with the problem software, can help correlate and trace temporally separated errors to show how they contribute to a larger problem. Anomalies in the logs can indicate potential failures or compromised attempts. The data can also help:

- Monitor user or customer transactions
- Identify abnormal volume/amount/session of transactions
- Identify unknown user interaction with third accounts, users or both
- Sequence the exact transaction patterns matching fraudulent profiles

MOBILE DEVICE DATA

Use Cases: IT Operations, Application Delivery, Security & Compliance

MIDDLEWARE DATA



Given the array of always-active sensors on mobile devices, they are veritable gushers of data that can include:

- Physical parameters such as location, network MAC ID, device GUID, device type and OS version
- Network settings such as address, AP or cell-base station location, link performance
- Application-specific telemetry such as time in app, features used and internal state and debug parameters similar to those provided by conventional application servers

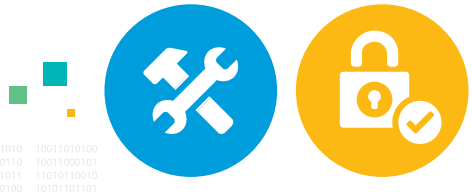
Use Cases:

IT Ops & Application Delivery: Since mobile apps invariably connect to one or more backend services, data from the client's point of view can provide insight into the app's condition and state when investigating issues such as crashes, performance degradation or security leaks. Mobile data shows the sequence of events and the application conditions leading up to and during a problem. If the source of the problem is the mobile application itself, getting insight on mobile application data can help developers deliver a better performing mobile app.

Security & Compliance: Security teams can expand the threat landscape by monitoring mobile device data for abnormal activity in regards to authentication, location and application usage.

SNMP

Use Cases: IT Operations, Security & Compliance
Examples: LogicMonitor, ManageEngine, Spiceworks, Ruckus Idera, Ipswitch



The simple network management protocol (SNMP) is one of the oldest, most flexible and broadly adopted IP protocols used for managing or monitoring networking devices, servers and virtual appliances. This includes network devices such as routers and switches, as well as non-networking equipment such as server hardware or disk arrays.

SNMP supports two different methods of obtaining data.

- **SNMP Traps** are essentially alerts, set to send an alert on a state change, critical threshold, hardware failure and more. Traps are initiated by the SNMP device, and the trap is sent to an SNMP collector.
- **SNMP Polling** is an interactive query/response approach. Unlike traps, polling is initiated by the SNMP collector in the form of a request for certain—or all—SNMP data available on the SNMP device.

Although many now provide vendor-specific APIs for remote management and data collection, SNMP is still valuable in troubleshooting due to its ubiquity (nearly every device supports it) and inherently centralized design (a single instance of SNMP management software can collect data from every device on an internal network, even across route domains).

Use Cases:

IT Ops: SNMP data can provide current information about performance, configuration and current state. This allows the monitoring of the "normal" state of the environment, which is vital when using a service-level approach to monitoring of health of any environment. This could include current speed of all of the ports on a switch, the number of bytes sent (per port or in aggregate) through a router, the CPU temperature of a server, and any other information made available by the vendor per the SNMP MIBs for that device.

Many environments rely on SNMP traps for alerting when a critical state is reached (e.g., CPU temperature is critical) or when a failure occurs (e.g., RAID disk failure). SNMP traps are not only sent by devices to monitoring systems, in some environments SNMP traps are the de-facto method for multiple monitoring and alerting systems to aggregate errors to a single console.

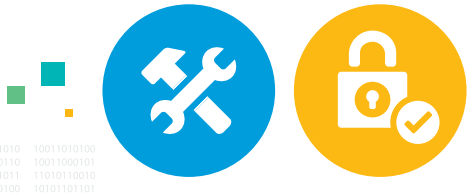
Security & Compliance: SNMP traps and alerts from network devices can help security teams identify abnormal activity over the network. SNMP Polling helps a security analyst to see the data transmission rates for a network-connected device that is suspected of malicious activity.

The data can also help identify abnormal amounts of traffic to a certain site or domain, an abnormal amount of specific SNMP traps from a certain host, and an abnormal number of unique SNMP traps from hosts compared to normal profiles.

DEEP PACKET INSPECTION DATA

Use Cases: IT Operations, Security & Compliance
Examples: Stream, PCAP, bro

NETWORK DATA



Deep Packet Inspection (DPI) is a fundamental technique used by firewalls to inspect headers and the payload of network packets before passing them down the network subject to security rules. DPI provides information about the source and destination of the packet, the protocol, other IP and TCP/UDP header information and the actual data.

Use Cases:

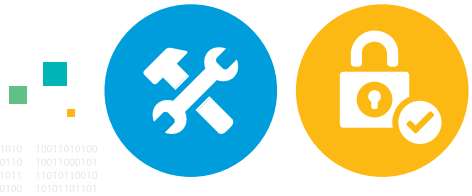
IT Ops: Data on the network wire is authoritative and difficult to spoof (although encryption, steganography and advanced deception techniques can evade DPI). For example, DPI provides raw information of everything transmitted over a network, including things that aren't necessarily part of or difficult to extract from a log, such as database query results.

Security & Compliance: Packet Capture logs (PCAP) see everything traversing a network and are required to identify security attacks and incidents such as advanced persistent threats, data exfiltration, DDoS and malware. DPI also can be used to filter content subject to an organization's terms of service. PCAP data can also be used to provide and identify:

- DNS session analysis for malicious domain communications from each endpoint
- Abnormal amounts of traffic or sessions
- Abnormal amounts of domain and host communications
- Known malicious traffic from a host
- Expired SSL certification analysis
- Abnormal host communications (internal and external)

DHCP

Use Cases: IT Operations, Security & Compliance
Examples: DHCP Insight, Linux DHCP



DHCP is the network protocol most client devices use to associate themselves with an IP network. Implemented via a DHCP server, which could be standalone or embedded in a router or other network appliance, DHCP provides network clients with critical network parameters including IP address, subnet mask, network gateway, DNS servers, WINS or other name servers, time servers (NTP), a host and domain name and the address of other optional network services.

Use Cases:

IT Ops: DHCP logs can be used when troubleshooting a client device that is having network problems since it provides a definitive record of the device's primary IP parameters. The data may show the DHCP server itself is at fault; for example, by not properly vending addresses, renewing IP leases or giving the same address to two separate devices.

Security & Compliance: DHCP logs show exactly which systems are connecting to a network, their IP and MAC addresses, when they connect and for how long. This information is useful in establishing the state of a network when a security incident occurs and tracing an attacker's address back to a time of access and type of device by looking at the MAC ID and vendor identification string. The data can also be used to support user network access verification.

ENDPOINT

Use Cases: Security & Compliance
Examples: McAfee ePO, Symantec SEP

Endpoint security is used to protect corporate networks from inadvertent attacks by compromised devices using untrusted remote networks such as hotspots. By installing clients on laptops or other wireless and mobile devices, endpoint security software can monitor activity and provide security teams with warnings of devices attempting to spread malware or pose other threats.

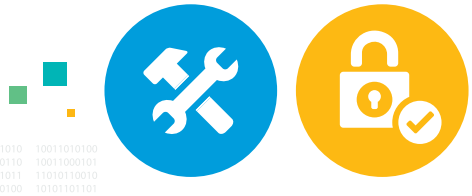
In this context, endpoint refers to the security client software or agent installed on a client device that logs security-related activity from the client OS, login, logout, shutdown events and various applications such as the browser (Explorer, Edge), mail client (Outlook) and Office applications. Endpoints also log their configuration and various security parameters (certificates, local anti-malware signatures, etc.), all of which is useful in post-hoc forensic security incident analysis.

Use Cases:

Security & Compliance: Endpoint data can be used for a variety of security uses, including identifying newly detected binaries, file hash, files in the filesystem and registries. It can also help with identifying binary and hash registries that match threat intelligence, as well as unpatched operating systems and binaries, and to detect known malware.

FIREWALL

Use Cases: IT Operations, Security & Compliance
Examples: Palo Alto, Cisco, Check Point



Firewalls demarcate zones of different security policy. By controlling the flow of network traffic, firewalls act as gatekeepers collecting valuable data that might not be captured in other locations due to the firewall's unique position as the gatekeeper to network traffic. Firewalls also execute security policy and thus may break applications using unusual or unauthorized network protocols.

Use Cases:

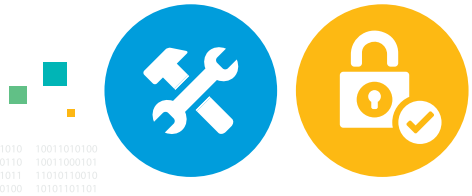
IT Ops: When network applications are having communication problems, network security policies may be the culprit. Firewall data can provide visibility into which traffic is blocked and which traffic has passed through – helping identify if you have an app or network issue.

Security & Compliance: Firewall logs provide a detailed record of traffic between network segments, including source and destination IP addresses, ports and protocols, all of which are critical when investigating security incidents. The data may also reveal gaps in security policy that can be closed with tighter construction of firewall rules. Firewall data can help identify and detect:

- Lateral movement
- Command and Control traffic
- DDoS traffic
- Malicious domain traffic
- Unknown domain traffic
- Unknown locations traffic

FTP

Use Cases: IT Operations, Security & Compliance
Examples: OSSEC, Getwatchlist, UTBox, Security Onion, iSeries - AS400, Traffic Ray



FTP is one of the oldest and most rudimentary network protocols for copying data from one system to another. Before websites and HTTP, FTP was the best way to move large files across the internet. FTP is still used in organizations that need reliable, deterministic internet file transfer.

Use Cases:

IT Ops: FTP traffic logs record the key elements of a file transmission, including source (client) name and address and remote user name if the destination is password-protected. This and other data are crucial when troubleshooting FTP problems, regardless of the application.

Security & Compliance: Analyzing FTP servers can help security teams identify when compromised credentials are used, when abnormal traffic is coming from different locations or at odd times, and when sensitive files and document are being accessed.

INTRUSION DETECTION/PREVENTION

Use Cases: Security & Compliance
Examples: Tipping Point, Juniper IDP, Netscreen Firewall, Juniper NSM IDP, Juniper NSM, Snort, McAfee IDS

NETWORK DATA

IDS and IPS are complementary, parallel security systems that supplement firewalls – IDS by exposing successful network and server attacks that penetrate a firewall, and IPS by providing more advanced defenses against sophisticated attacks. IDS is typically placed at the network edge, just inside a perimeter firewall, although some organizations also put a system outside the firewall to provide greater intelligence about all attacks. Likewise, IPS is typically placed at the network perimeter, although it also may be used in layers at other points inside the network or on individual servers. IPS usually works by dropping packets, resetting network connections and blacklisting specific IP addresses or ranges.

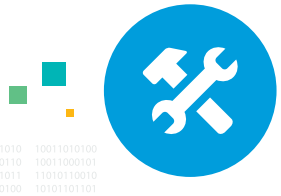
Use Cases:

Security & Compliance: IDS logs provide security teams detailed records of attacks including the type, source, destination and port(s) used that provide an overall attack signature. Special signatures may trigger alarms or other mitigating actions. IPS provide the same set of attack signature data, but also may include a threat analysis of bad network packets and detection of lateral movement. This data can also detect command and control traffic, DDoS traffic, and malicious or unknown domain traffic.

LOAD BALANCER

Use Cases: IT Operations
Examples: Local Traffic Manager, Cisco Load Balancer, Citrix, Kemp Technologies, Radware AppDirector OnDemand

NETWORK DATA



Load balancers allocate external network traffic bound for a particular server or application across multiple redundant instances. There are two categories of load balancer: local, in which all resources in a load-balanced pool are on the same subnet; and global or distributed, where the resource pool is spread across multiple sites. Load balancers use several user-selectable algorithms to allocate traffic including:

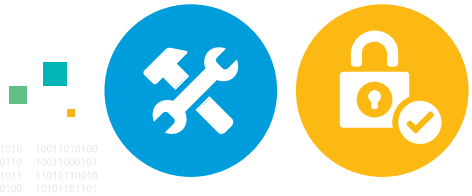
- Round robin (systems get an equal number of connections allocated sequentially)
- Weighted round robin (where the load is assigned according to the percentage weight assigned each system in a pool)
- Least connections (where new connections go to the system with the fewest number of existing clients)
- Weighted least connections (where the connection handling capacity of each system is taken into account when determining the least busy system for new connections)
- Random (connections are randomly assigned to each member of a pool)

Use Cases:

IT Ops: Load balancer logs provide operations teams with a record of overall traffic to systems or particular applications and provide indicators of each system's traffic-handling capacity and health, along with the status and health of the load balancer itself.

DNS

Use Cases: IT Operations, Security & Compliance
Examples: BIND, PowerDNS, Unbound, Dnsmasq, Erl-DNS



The domain name system (DNS) is the internet's phone book, providing a mapping between system or network resource names and IP addresses. DNS has a hierarchical name space that typically includes three levels: a top-level domain (TLD) such as .com, .edu or .gov; a second-level domain such as "google" or "whitehouse;" and a system level such as "www" or "mail." DNS nameservers operate in this hierarchy either by acting as authoritative sources for particular domains, such as a company or government agency, or by acting as caching servers that store DNS query results for subsequent lookup by users in a specific location or organization; for example, a broadband provider caching addresses for its customers.

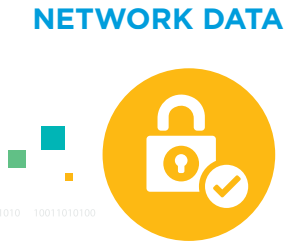
Use Cases:

IT Ops: DNS server logs provide operations teams with a record of traffic, the type of queries, how many are locally resolved either from an authoritative server or out of cache, and a picture of overall system health.

Security & Compliance: Security teams can use DNS logs to investigate client address requests such as correlating lookups with other activity, whether requests are made for inappropriate or otherwise suspicious sites and relative popularity of individual sites or domains. Since DNS servers are a frequent target of DDoS attacks, logs can reveal an unusually high number of requests from external sources. Likewise, since compromised DNS servers themselves are often used to initiate DDoS attacks against other sites, DNS logs can reveal whether an organization's servers have been compromised. DNS data can also provide detection of unknown domains, malicious domains and temporary domains.

NETWORK ACCESS CONTROL (NAC)

Use Cases: Security & Compliance
Examples: Aruba ClearPass, Cisco ACS



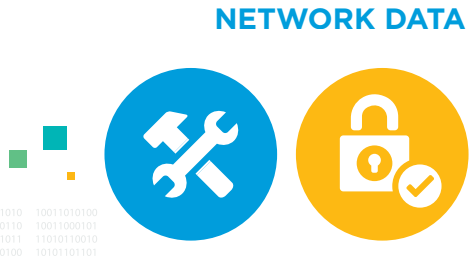
Network access or admission control is a form of client/endpoint security that uses a locally installed software agent to pre-authorize connections to a protected network. NAC screens client devices for contamination by known malware and adherence to security policies such as running an approved OS with the most recent patches. Clients failing NAC screens are rerouted to an isolated quarantine network until any detected problems are corrected.

Use Cases:

Security & Compliance: NAC software collects data about the connecting clients such as an inventory of installed client software, compliance with security policies, OS and application patch versions, accessibility by remote access clients and user access to protected networks. NAC logs provide security teams with a detailed profile of a client's state and activity. It can provide details into unauthorized device connections and be used to correlate users/IP to a physical network location.

NETWORK SWITCHES

Use Cases: IT Operations, Security & Compliance
Examples: Ethernet Switch, Virtual Switches



Switches are network intersections, places where packets move from one network segment to another. In their purest form, switches work within a particular IP subnet and can't route Layer 3 packets to another network. Modern data center designs typically use a two-tier switch hierarchy: top-of-rack (ToR) switches connecting servers and storage arrays at the edge, and aggregation or spine switches connecting to the network core. Although ethernet switches are far more widespread, some organizations also use fiber channel or infiniband for storage area networks or HPC interconnects, each of which has its own type of switch.

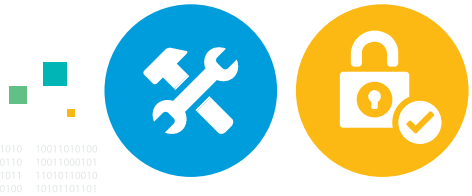
Use Cases:

IT Ops: Operations teams use switch logs to see the state of traffic flow, such as source and destination, class of service and causes of congestion. Logs can show traffic statistics in the aggregate, by port and by client, and whether particular ports are congested, failing or down.

Security & Compliance: Switch data, often captured as NetFlow records, is a critical data source for flagging advanced persistent threats, analyzing traffic flows for unusual activity and identifying potential data exfiltration. As a wire-level data source, switch statistics are almost impossible to spoof and thus a crucial source of security data. This data can also be used to correlate users or IP addresses to a physical network location.

NETWORK ROUTERS

Use Cases: IT Operations, Security & Compliance
Examples: Routers from Cisco, Juniper, Linksys, Arista, Extreme Networks, Avaya



If switches are network intersections, then routers are the signal lights and traffic cops—the devices responsible for ensuring that traffic goes to the right network segment. Unlike switches that operate at Layer 2, routers work at Layer 3, directing traffic based on TCP/IP address and protocol (port number). Routers are responsible for particular Layer 3 address spaces and manage traffic using information in routing tables and configured policies. Routers exchange information and update their forwarding tables using dynamic routing protocols.

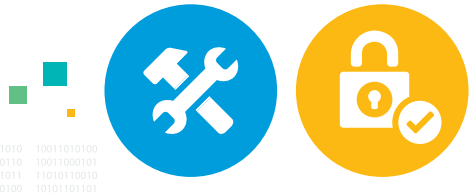
Use Cases:

IT Ops: Network engineers use router logs and statistics to monitor traffic flow and ensure that traffic is being correctly forwarded between network segments. Data from routing protocol updates can show whether your routers are appropriately exchanging route tables with other locations, that external traffic can reach you, and that internal traffic is correctly forwarded to external routers.

Security & Compliance: Routers collect the same sort of traffic logs and statistics as switches; thus, their data is equally valuable to security teams as a source for flagging advanced persistent threats, analyzing traffic flows for unusual activity and identifying potential data exfiltration. As a wire-level data source, router statistics are almost impossible to spoof and thus a critical source of security data. Router data can also be used to detect configuration changes and error or failure alerts correlating with security indicators.

NETWORK PROTOCOLS

Use Cases: IT Operations, Security & Compliance
Examples: HTTP, Cisco NetFlow, Ntop, Flow-tools, FlowScan, EHNT, BPFT



Network protocols describe the structure of data that flows through networks. In most cases, network ports are assigned to specific protocols for both security and performance reasons. Some protocols operate at a lower level of the computing stack and are used to direct packet routing, such as TCP, UDP or IP. Other protocols, such as HTTP, HTTPS and TNS describe how packets are structured for applications – such as web services, databases and a wide range of client-based applications. By capturing, decrypting and analyzing network protocol data, you can better understand the kinds of applications, their usage, performance and even payload (content of the data) of applications. Since this data can be gathered directly from a network tap, or with specialized software, it provides a perspective on applications and how they interoperate that may not be otherwise available.

Use Cases:

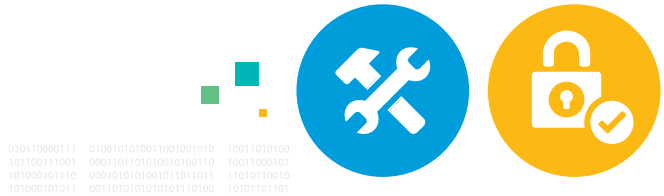
IT Ops: Network protocol traffic analysis can help determine the network's role in overall availability and performance of critical services. Application traffic can be monitored for usage, performance and availability, and can provide visibility into specific user data. For applications that cannot be instrumented on the servers, network traffic may be the only way to acquire performance data.

Security & Compliance: Network protocols are an important source for identifying advanced persistent threats, analyzing traffic flows for unusual activity and identifying potential data exfiltration. Aggregating and analyzing flow records also can show anomalous traffic patterns and flow destinations that are indicative of a breach, such as an APT phoning home to a command and control server for instructions, additional malware code, or copying large amounts of data to an attacker's system. The data can also be used to detect traffic related to DDoS, malicious domains, and unknown domains or locations.

PROXIES

Use Cases: IT Operations, Security & Compliance
Examples: Blue Coat, Fortinet, Juniper IDP, Netscreen Firewall, Palo Alto Networks, nginx

NETWORK DATA



Network proxies are used in several ways in IT infrastructure: as web application accelerators and intelligent traffic direction, application-level firewalls and content filters. By acting as a transparent 'bump-in-the-wire' intermediary, proxies see the entire Layer 7 network protocol stack, which allows them to implement application-specific traffic management and security policies.

Use Cases:

IT Ops: Operations teams often use proxies embedded in an application delivery controller (ADC), a more advanced Layer 7-aware version of a load balancer. In this context, proxy logs can provide information about incoming requests and traffic distribution among available resources.

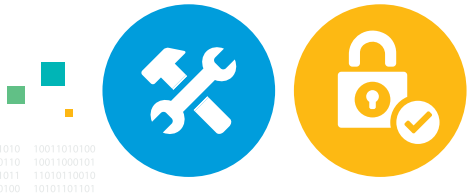
Security & Compliance: Proxy records can identify details about specific content traversing network control points including file names, types, source and destination, and metadata about the requesting client such as OS signature, application and username/ID (depending on the proxy implementation). The data can also be used to help detect command and control traffic, malicious domain traffic and unknown domain traffic.

Web proxies and some next generation firewalls may act in a transparent or explicit mode communicating with HTTP(s) servers on behalf of a client. Using a number of related technologies, the request and response can be inspected and permitted, or blocked, based on user role, site or resource category or attack indicator. Data logged in the events can potentially be used in detective correlation.

VoIP

Use Cases: IT Operations, Security & Compliance
Examples: Asterisk CDR, Asterisk event, Asterisk messages

NETWORK DATA



Voice over IP refers to several methods for transmitting real-time audio and video information over an IP-based data network. Unlike traditional phone systems using dedicated, point-to-point circuits, VoIP applications use packet-based networks to carry real-time audio streams that are interspersed with other ethernet data traffic. Since TCP packets may be delivered out of order due to data loss and retransmission, VoIP includes features to buffer and reassemble a stream. Similarly, VoIP packets are usually tagged with quality of service (QoS) headers to prioritize their delivery through the network.

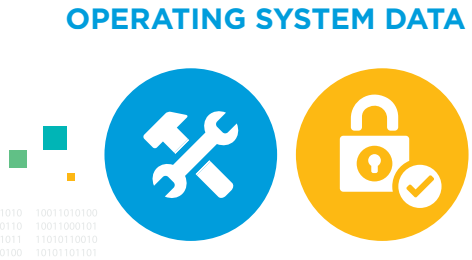
Use Cases:

IT Ops: VoIP logs provide troubleshooting and usage data similar to that of other network applications. Details include source, destination, time and duration of calls, call quality metrics (e.g., packet loss, latency, audio fidelity/bit rate) and any error conditions. Integrating VoIP source/destination records with an employee database such as AD or LDAP and a DHCP database allows linking call records to actual people and IP addresses to physical locations; information that can assist in troubleshooting and billing.

Security & Compliance: VoIP deployments may expose organizations to potential security threats, and analyzing VoIP logs can help identify and prevent these exploits.

SYSTEM LOGS

Use Cases: IT Operations, Application Delivery, Security & Compliance
Examples: Unix, Windows, Mac OS



Every OS records details of its operating conditions and errors, and these time-stamped logs are the fundamental and authoritative source of system telemetry. Depending on the OS, there may be separate logs for different classes of events, such as routine informational updates, system errors, boot loader records, login attempts and debug output. Error logs often aggregate records from multiple subsystems and OS services or daemons, and, thus, are a definitive source of troubleshooting information.

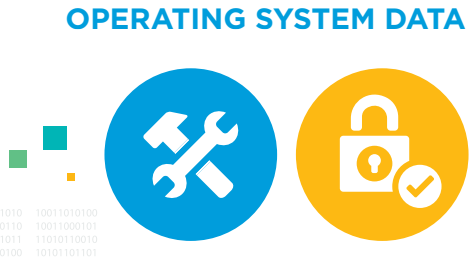
Use Cases:

IT Ops & Application Delivery: System logs often are the first place operations teams turn when troubleshooting system problems, whether with the OS, hardware or various I/O interfaces. Since a particular problem often manifests itself with errors in multiple subsystems, correlating log entries is one of the best ways of identifying the root cause of a subtle system failure.

Security & Compliance: System logs include a variety of security information such as attempted logins, file access and system firewall activity. These entries can alert security teams to network attacks, a security breach or compromised software. They also are an invaluable source of information in forensic analysis of a security incident. For example, the data can be used to identify changes in system configurations and commands executed by users or privileged users.

SYSTEM PERFORMANCE

Use Cases: IT Operations, Application Delivery, Security & Compliance
Examples: PERFMON, Windows Events Logs, sar, vmstat, iostat



Measures of system activity such as CPU load, memory and disk usage, and I/O traffic are the IT equivalent of EKGs to a doctor: the vital signs that show system health. Recording these measures provides a record of system activity over time that shows normal, baseline levels and unusual events. By registering myriad system parameters, performance logs also can highlight mismatches between system capacity and application requirements, such as a database using all available system memory and frequently swapping to disk.

Use Cases:

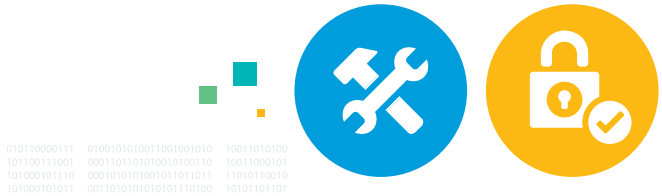
IT Ops & Application Delivery: Performance logs provide a real-time indication of system health by showing resource usage that, when compared with historical norms, flags performance problems. When measurements deviate from standard or typical parameters, it's a warning for IT admins to do further investigation.

Security & Compliance: While primarily used for keeping infrastructure up and running, monitoring system performance can also be used to uncover potential security incidents by detecting abnormal activity in performance. One example is abnormal system resource usage in correlation with a security indication.

AMAZON WEB SERVICES

Use Cases: IT Operations, Security & Compliance
Examples: CloudTrail, CloudWatch, Config, S3

VIRTUAL INFRASTRUCTURE DATA



AWS is the largest and most widely used public cloud infrastructure, providing on-demand compute, storage, database, big data and application services with consumption-based pricing. AWS can be used to replace traditional enterprise virtual server infrastructure in which software runs on individual virtual machines (VM) or to host cloud-native applications built from a collection of AWS services. AWS includes a host of service management, automation, security, network and monitoring services used to deploy, scale, decommission, audit and administer one's AWS environment, subscriptions and hosted applications.

Use Cases:

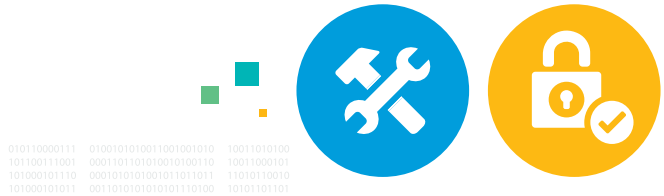
IT Ops: AWS services provide similar types of system and service data as traditional IT infrastructure, much of which is consolidated by the CloudWatch service. These include service monitoring, alarms and dashboards for metrics, logs, and events generated by other AWS resources and applications. Typical events and measures include when instances are instantiated and decommissioned, CPU usage, network traffic and storage consumption.

Security & Compliance: Security data from AWS services includes login and logout events and attempts, API calls and logs from network and web application firewalls.

MICROSOFT AZURE

Use Cases: IT Operations, Security & Compliance
Examples: WADLogs, WADEventLogs, WADPerformanceCounter, WADDiagnostInfrastructure

VIRTUAL INFRASTRUCTURE DATA



Azure is a popular and widely used public cloud infrastructure, providing on-demand compute, storage, database, big data and application services with consumption-based pricing. Azure can be used to replace traditional enterprise virtual server infrastructure in which software runs on individual VMs, or to host cloud-native applications built from a collection of Azure services. Azure includes a host of service management, automation, security, network and monitoring services used to deploy, scale, decommission, audit and administer one's Azure environment, subscriptions and hosted applications.

Use Cases:

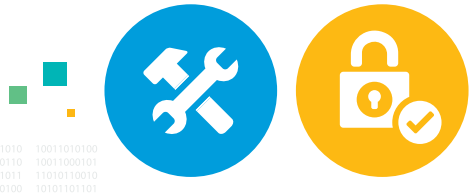
IT Ops: Azure services provide detailed logs for monitoring one's infrastructure across entire technology stack, VMs, containers, storage and application services. The data is useful in maintaining application delivery quality and service levels, measuring user behavior, resource utilization and for capacity planning and cost management.

Security & Compliance: Security teams can use Azure service logs to audit and attest to compliance with established policies. Log data also is invaluable for incident forensic analysis, such as identifying unauthorized access attempts from access logs, tracking resources and configuration change events and identifying vulnerabilities in hosts or firewalls.

VMware SERVER LOGS, CONFIGURATION DATA AND PERFORMANCE METRICS

Use Cases: IT Operations, Security & Compliance
Examples: vCenter, ESXi

VIRTUAL INFRASTRUCTURE DATA



VMware vSphere ESXi is the most commonly used enterprise server virtualization platform. The VMware management platform, whether one of the vSphere products, vCloud or standalone hypervisor, produce a variety of data, fall into four main categories:

- **vCenter logs** - vCenter is the "control center" of a vSphere environment. The vCenter logs show information including: who is logging in to make changes, which individuals made changes and authentication failures.
- **ESXi logs** - every vSphere environment includes one or more ESXi hypervisors; these are the systems that host the virtual machines. ESXi logs contain information that is useful when troubleshooting hardware and configuration issues.
- **Inventory information** - the vCenter environment tracks configuration about a number of items including: hypervisors, virtual machines, datastores, clusters and more. This includes the configuration of each item, and how a given item relates to any other. This information is not represented in the log files from either the vCenter or ESXi servers. This information can be viewed using the vSphere client or by using vSphere APIs to pull this information. In both cases this information is pulled from the vCenter servers.
- **Performance information** - for each configuration item, the vCenter server tracks a number of performance metrics about that item. Datastore latency, virtual or physical CPU utilization, and over 100 other metrics fall into this category. As with the inventory information, this information is not present in the log files and must be viewed through the vSphere client or polled through the vSphere API.

Use Cases:

IT Ops: Operations teams can use VMware data to measure the health of the overall hypervisor environment and underlying guest operating systems. Admins can use this data for capacity planning and for troubleshooting of ongoing performance issues, such as datastore latency issues.

This data also records hardware resource usage that can be used to optimize VM deployments across a server pool to maximize resource consumption without having workloads overwhelm any given server.

Security & Compliance: The uncoupled nature of virtual resources and underlying physical hardware can cause complex challenges during incident investigations, capacity analyses, change tracking and security reporting. One common security use case for VMware data comes from the vCenter logs, which audit the activity of individuals using the vSphere interface to re-assign user permissions within the VMware environment.

PHYSICAL CARD READERS

Use Cases: Security & Compliance

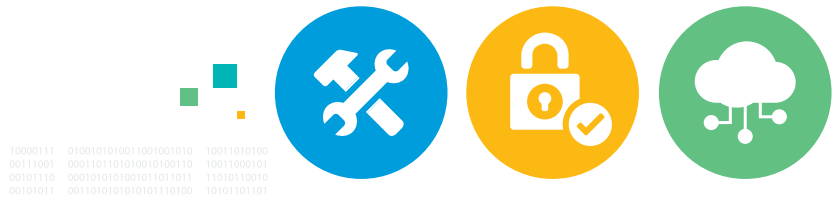
Most organizations use automated systems to secure physical access to facilities. Historically, these have been simple magnetic strips affixed to employee badges; however, locations with stringent security requirements may use some form of biometric reader or digital key. Regardless of the technology, the systems compare an individual's identity with a database and activate doors when the user is authorized to enter a particular location. As digital systems, badge readers record information such as user ID, date and time of entry and perhaps a photo for each access attempt.

Use Cases:

Security & Compliance: For IT security teams, the data from card readers provide the same sort of access information for physical locations as a network firewall log. The data can be used to detect attempted breaches and be correlated to system and network logs to identify potential insider threats and provide overall situational awareness. It can also be used to detect access at unusual times and locations or for unusual durations.

SENSOR DATA

Use Cases: IT Operations, Security, Business Analytics, Internet of Things
Examples: Binary and numeric values including switch state, temperature, pressure, frequency, flow, from MQTT, AMQP and CoAP brokers, HTTP event collector



Industrial equipment, sensors and other devices often have embedded processors and networking that allows them to record and transmit a vast array of information about operating conditions. Regardless of device, their data provides unprecedented detail about performance parameters and anomalies that can indicate larger problems—for example, a device ready to fail or issues with another system. Aggregating and correlating data from multiple devices and subsystems provides a complete picture of equipment, system, factory or building performance.

Use Cases:

IT Ops: Some of the most important parameters for operations teams to monitor are environmental conditions such as temperature, humidity, airflow and voltage regulation in a data center. Similar readings are available from individual servers and network equipment that, when correlated, can highlight problems in the facility or equipment ready to fail.

Security & Compliance: Sensor data can help protect mission-critical assets and industrial systems against cybersecurity threats by providing visibility into system performance or set points that could put machines or people at risk. Data can also be used to satisfy compliance reporting requirements.

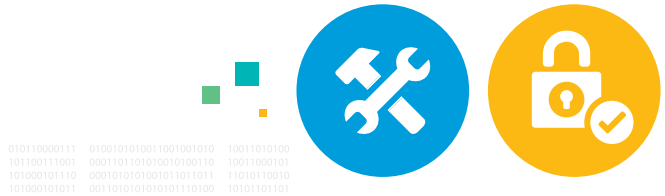
Internet of Things:

Preventative Maintenance and Asset Lifecycle Management: Sensor data can provide insights into asset deployment, utilization and resource consumption. Operational data can also be used to proactively approach long-term asset management, maintenance and performance.

Monitoring and Diagnostics: Monitoring sensors can help ensure that equipment in the field operates as intended, for example, monitoring and tracking unplanned device or system downtime. The data can also be used to understand the cause of failure on a device to improve efficiency and availability, and to identify outliers and issues in device production or deployment.

SERVER LOGS

Use Cases: IT Operations, Security & Compliance, Application Delivery



Server operating systems routinely record a variety of operational, security, error and debugging data such as system libraries loaded during boot, application processes open, network connections, file systems mounted and system memory usage. The level of detail is configurable by the system administrator; however, there are sufficient options to provide a complete picture of system activity throughout its lifetime. Depending on the subsystem, server logs are useful to system, network, storage and security teams.

Use Cases:

IT Ops & Application Delivery: Server logs provide a detailed record of overall system health and forensic information about the exact time of errors and anomalous conditions that are invaluable in finding the root cause of system problems.

Security & Compliance: Server logs include data from security subsystems such as the local firewall, login attempts and file access errors that security teams can use to identify breach attempts, track successful system penetrations and plug vulnerabilities. Monitoring server logs such as file access, authentication and application usage can help secure infrastructure components.

BACKUP

Use Cases: IT Operations

Despite the use of data replication to mirror systems, databases and file stores, data backup remains an essential IT function by providing for long-term, archival storage of valuable information, much of which has legal and regulatory requirements regarding its preservation. Backups also can be used to store multiple versions of system images and data, allowing organizations to reverse changes, accidental deletions or corrupted data quickly, restoring the system or database to a known good state. Backup software can use different types of storage media depending on the likelihood of needing the data: external disks or virtual tape libraries for active data and tape, optical disks or a cloud service for long-term storage.

Use Cases:

IT Ops: Backup systems routinely log activity and system conditions, recording information such as job history, error conditions, backup target and a detailed manifest of copied files or volumes. This data allows operations teams to monitor the health of backup systems, software and jobs; triggers alerts in the case of errors; and assists in debugging backup failures. It also allows teams to locate where specific data may be stored, when a recovery is required.

STORAGE

Use Cases: IT Operations
Examples: EMC, Netapp, IBM

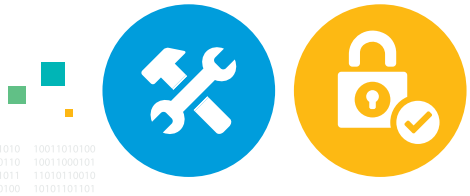
Data center storage is provisioned in two general ways: built into servers and shared using various network storage protocols, or via a dedicated storage array that consolidates capacity for use by multiple applications that access it using either a dedicated storage area network (SAN) or ethernet LAN file-sharing protocol. The activity of internal, server-based storage is typically recorded in system logs, however storage arrays have internal controllers/storage processors that run a storage-optimized OS and log a plethora of operating, error and usage data. Since many organizations have several such arrays, the logs often are consolidated by a storage management system that can report on the aggregate activity and capacity.

Use Cases:

IT Ops: Shared storage logs record overall system health (both hardware and software), error conditions (such as a failed controller, network interface or disks) and usage (both capacity used per volume and file or volume accesses). Collectively, the information can alert operations teams to problems, the need for more capacity and performance bottlenecks.

MAINFRAME

Use Cases: IT Operations, Security & Compliance



Mainframes are the original business computer: large, centralized systems housing multiple processors, system memory (RAM) and I/O controllers. Despite their 60-year legacy, mainframes still are widely used for mission-critical applications, particularly transaction processing. Although they usually run a proprietary OS, mainframes also can be virtualized to run Unix and Linux or, with add-on processor cards, Windows Server. Mainframes are valued for their bulletproof reliability and security, using highly redundant hardware and resilient, stringently tested software. As such, they appeal to organizations wanting to consolidate workloads onto a small number of systems and that need the added reliability and versatility.

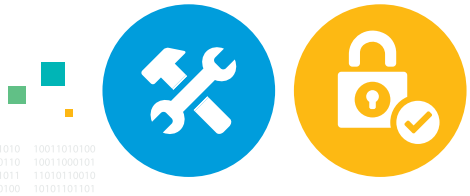
Use Cases:

IT Ops: Like other servers, mainframes measure and log numerous system parameters that show their current status, configuration and overall health. Since most mainframe subsystems are redundant, system logs also show non-disruptive hardware failures or anomalous behavior that is predictive of an impending failure. Due to their use for critical applications, mainframes often record application performance data such as memory usage, I/O and transaction throughput, processor utilization and network activity.

Security & Compliance: Mainframes contain critical operational data. In a security context, mainframe data is treated like any other enterprise data that requires visibility and monitoring for data confidentiality and integrity, compliance and audits with regulatory requirements, and for access monitoring.

PATCH LOGS

Use Cases: IT Operations, Security & Compliance



Keeping operating systems and applications updated with the latest bug fixes and security patches is an essential task that can prevent unplanned downtime, random application crashes and security breaches. Although commercial apps and operating systems often have embedded patching software, some organizations use independent patch management software to consolidate patch management and ensure the consistent application of patches across their software fleet and to build patch jobs for custom, internal applications.

Patch management software keeps a patch inventory using a database of available updates and can match these against an organization's installed software. Other features include patch scheduling, post-install testing and validation and documentation of required system configurations and patching procedures.

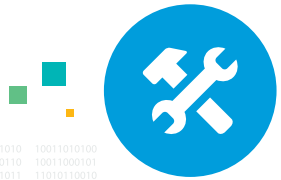
Use Cases:

IT Ops: Operations teams use patch logs to verify the timely and correct application of scheduled patches, identify unpatched systems and applications, and alert to errors in the patching process. Correlating errors to patch logs can indicate when an error is due to a patch.

Security & Compliance: Security teams can use patch logs to monitor system updates and determine which assets could be at risk, due to failed or out-of-date patches.

TELEPHONY

Use Cases: IT Operations
Examples: Cisco Unified Communications Manager, Shoretel, Twilio



Real-time business communications are no longer limited to voice calls provided by plain old telephone service (POTS); instead, voice, video, text messaging and web conferences are IP applications delivered over existing enterprise networks. Unlike traditional client-server or web applications, telephony and other communications applications have strict requirements on network quality of service, latency and packet loss, making service quality and reliability much more sensitive to network conditions and server responsiveness. Traditional POTS has conditioned people to expect immediate dial tone when picking up the phone and be intolerant of noise, echo or other problems that can plague IP telephony; as such, the systems and supporting infrastructure require careful monitoring and management to assure quality and reliability.

Use Cases:

IT Ops: Like VoIP, telephony logs provide an overview of system health along with troubleshooting and usage data similar to that of other network applications. Details include source, destination, time and duration of voice/video calls, web conferences and text messages, call-quality metrics (e.g., packet loss, latency, audio fidelity/bit rate), error conditions and user attendance at web conferences. By integrating telephony records of source/destination address with an employee database such as AD or LDAP and a DHCP database, organizations can link call records to actual user IDs and IP addresses to physical locations; information that can assist in troubleshooting and billing. Logs also can reveal any network segments experiencing congestion or other performance problems that may indicate equipment problems or the need for an upgrade.

POINT-OF-SALE SYSTEMS (POS)

Use Cases: Internet of Things, Business Analytics, Security & Compliance
Examples: IBM, LightSpeed, NCR, Revel Systems, Square, Toshiba, Vend

Point-of-sale (POS) systems are most often associated with transactions generated at a retail outlet. However, thanks to the rise of mobile POS solutions, many of these systems are starting to be deployed in temporary locations, such as a community fair or a high school event.

The typical POS system incorporates a cash register based on a PC or embedded system, monitor, receipt printer, display, barcode scanner and debit/credit card reader. Machine data generated by POS systems provides organizations with real-time insight into everything from what's sold, to the amount of cash being generated per transaction, to what payment methods are being used.

Use Cases:

Internet of Things: Historically, POS systems were either not connected or managed on a dedicated private network. Thanks to the rise of the Internet of Things (IoT), these systems are being connected directly to cloud platforms that make remotely administering these devices from a central location much simpler. There's no longer a need to dispatch IT personnel to manually update each system. This is critical because a POS failure can result in longer lines that inconvenience customers and potentially lead to lost revenue. A negative customer experience can easily translate to customers opting to shop somewhere else in a retail industry that is intensely competitive.

Business Analytics: POS system contain information about what's sold, how it's paid for, as well as the pace at which it's being sold. Organizations can use this data to monitor revenue in real time, which can feed into how to better market 1:1 against customers, track product placement and sales in a store, or detect potentially fraudulent transactions in real time. This type of real-time big data analysis can have profound impact on cross- and up-sell opportunities. POS data also delivers visibility into the customer experience, such as which coupons are most popular or the combinations of products that are selling together. When enriched with geolocation data, it can also drive valuable insights into location-based analytics.

Security & Compliance: POS systems are typically used for financial transactions and are often targeted since they contain account, payment and financial information. Because the POS transaction information is highly sought after for its value to attackers, and the POS can be used as an entry point to the network, it's critical to protect these systems. Furthermore, POS systems are usually unmanned, run an underlying operating system, and versioning/monitoring typically fall outside of IT's purview – adding additional complexity to their security. Visibility and analysis of POS systems and data can provide insights that are critical to protecting financial information, detecting fraud and securing vulnerabilities.

RFID/NFC/BLE

Use Cases: Internet of Things, Business Analytics
Examples: Alien Technology, BluVision, Check Point Systems, Gimbal, MonsoonRF, Radius Networks, STMicroelectronics, TAGSYS RFID, ThingMagic

RFID, NFC and BLE are the three primary wireless methods organizations use today to keep track of objects and interact with customers in retail stores. NFC is a subset of RFID and is designed to be a more secure form of data exchange, and allows devices to communicate peer-to-peer. Common use cases of RFID are asset tracking, inventory management, even attendee tracking. NFC is commonly used for contact-less payments, exchanging information between two parties (such as smartphones), and even badge readers that unlock doors.

At the same time, organizations are adopting Bluetooth Low Energy (BLE) wireless connectivity solutions that can broadcast signals to other devices. BLE is used most widely in beacons that are employed, for example, to inform shoppers of new sales in retail stores on their smartphones or to update fans on events that might be occurring during a sporting event.

Use Cases:

Internet of Things: RFID is arguably one of the first instances of an Internet of Things (IoT) application. Deployed in place of traditional barcode readers, RFID tags are used in everything from shipping to keeping track of farm animals. IoT deployments make it possible to capture RFID data in way that makes it simpler to track events involving anything that has an attached RFID tag. Data insights from RFID can help improve overall supply chain, order processing and inventory management.

BLE, meanwhile, is used to engage customers more directly as they move about a specific location, which in turn creates data that can be used to optimize the customer experience.

Business Analytics: Whether it's inventory tracked using RFID tags or customers and employees moving around specific locations, new classes of analytics applications are using the data generated by these devices to serve up actionable business insights in near real time. Retailers can leverage this data for several use cases, such as making sure that inventory is located as close as possible to the locations where customers are most likely to want to purchase.

SMART METERS

Use Cases: Internet of Things, Business Analytics
Examples: ABB, GE, Google, eMeter, IBM, Itron, Schneider Electric, Siemens

Smart meters record consumption of energy, usage of water, or usage of natural gas so that the information can be continually processed and shared. Typically, smart meters allow for bi-directional communication in real time in a way that allows a gauge of some type to be adjusted.

Use Cases:

Internet of Things: Smart meters are deployed across critical systems at large utilities companies, for example, power, gas and water utilities. These systems are the lifeblood of infrastructure and failure can lead to catastrophic outcomes. Real time monitoring of smart meters can help organizations better analyze failures remotely, by way of remotely detecting line down failures. Equally important is securing the devices from tampering that could lead to malicious attacks and breaches.

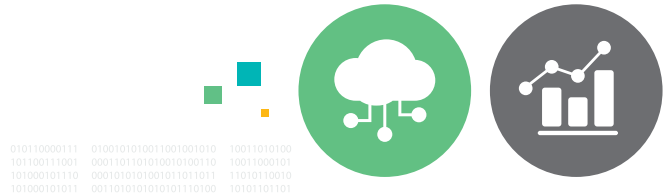
Energy companies and water utilities make extensive use of smart sensors to track everything from oil reserves to the quality of the water supply.

Business Analytics: A wide variety of industries are applying analytics to the data being collected by smart meters to optimize service. For example, an oil or gas company no longer needs to physically send a worker to a location to read a meter. The provider already knows how much fuel has been consumed and how much remains.

In the future, smart meters will be used in everything from modern traffic control systems to defense systems designed to protect critical infrastructure. Aggregating data from these smart meters can give utilities critical insights into the demand. Heavily regulated utilities are required to meet established SLA's during demand response events, and machine data from smart meters can drive visibility into how they are responding.

TRANSPORTATION

Use Cases: Internet of Things, Business Analytics
Examples: Boeing, BMW, Ford, GE, General Motors, Daimler-Benz, John Deere, Volkswagen



Vehicles of all sizes and types generate massive amounts of machine data. This data can be used to gain real-time visibility into the health and performance of the vehicle and to drive predictive maintenance applications. Armed with that data, an airplane or automobile manufacturer can follow a maintenance regime that is more data driven than driven "by the book."

That information can then be used to improve availability and reliability, and extend the lifecycle of a vehicle that has not been extensively used or, conversely, replace components that have seen extensive wear and tear sooner.

Use Cases:

Internet of Things: Vehicle manufacturers are attaching sensors to every mechanical and electronic component they use. This allows companies to gain a unified view of assets to quickly identify and diagnose operational issues and to monitor, track and avoid unplanned asset downtime. This helps to ensure that equipment is operating as intended. Manufacturers can also detect anomalies and deviations from normal behavior to take corrective action – improving uptime, asset reliability and longevity.

Business Analytics: With access to machine data, vehicle manufacturers are applying analytics in ways that fundamentally change their business models. Instead of selling a vehicle, manufacturers increasingly prefer to lease vehicles based on actual usage. The longer that vehicle can be used between repairs, the more profitable that leasing service becomes. The key to providing this type of service economically is advanced analytics, which are applied to all the aggregate data that's collected.

MEDICAL DEVICES

Use Cases: Internet of Things, Business Analytics, Security & Compliance
Examples: Abbot Laboratories, Apple, Baxter, Boston Scientific, GE, Siemens, St. Jude Medical

Everything from intensive care units to wearable devices generates multiple types of machine data. In fact, just about every aspect of patient care inside and out of a hospital setting can be instrumented. While the primary goal is to save lives, a crucial secondary goal is to reduce healthcare costs by reducing the both the number of potential visits to a hospital as well as the length of stay.

Use Cases:

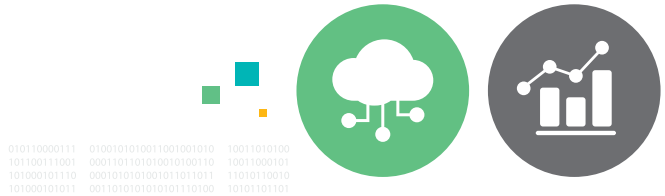
Internet of Things: Most devices inside a hospital are connected to local monitoring applications. But it's possible to monitor patient care remotely using sensors that communicate with either a wearable device or some other system for monitoring patients in their homes.

Business Analytics: Machine data also makes it simpler for medical professionals to analyze both patient and anonymous data across a broader range of geographically distributed regions—for example, to see how certain diseases are affecting one group of people more than another. These insights can also be used to help improve patient experience and deliver better care.

Security & Compliance: Medical devices run on operating systems and applications, and since they run in a controlled manner, the devices can be behind on patching levels making them susceptible to vulnerabilities. Analyzing this data can provide visibility into potential malicious activity or compromised protected health information (PHI).

ENVIRONMENTAL SENSORS

Use Cases: Internet of Things, Business Analytics
Examples: Bosch Sensortec, Mouser Electronics, Raritan, Schneider Electric, TSI, Vaisala



Environmental sensors provide data on barometric air pressure, humidity, ambient air temperature and air quality. They are applied in everything from combating pollution and detecting gasses to keeping data centers from overheating.

Use Cases:

Internet of Things: Environmental sensors are a class of smart meters that have been optimized to monitor the environment. In some instances, such as a data center, the information provided by these sensors is used to automatically alter temperature setting and heat flow.

Business Analytics: Environmental sensor data collect can be used in retail applications to answer predictive questions, such as “what impact will inclement weather have on foot traffic in a mall?”

INDUSTRIAL CONTROL SYSTEMS (ICS)

Use Cases: Internet of Things, Business Analytics, Security & Compliance
Examples: ABB, Emerson Electric, GE, Hitachi, Honeywell, Rockwell Automation, Siemens, Toshiba

PHYSICAL INFRASTRUCTURE & IoT DATA

Within the context of a manufacturing environment, industrial control systems make use of programmable logic controllers to both acquire data and execute supervisory functions. Much of the process automation employed in a manufacturing facility is enabled by the industrial control systems.

Use Cases:

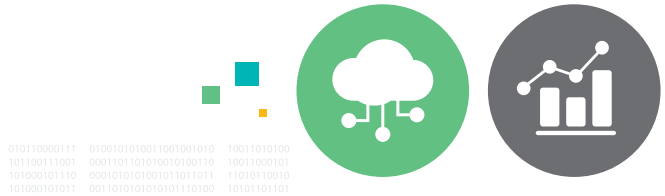
Internet of Things: Machine data from ICS can be used to gain real-time visibility into the uptime and availability of critical assets. This enables companies to detect an issue, perform root cause analysis and take preventive action to prevent certain events from happening in the future. Companies are also leveraging machine data from ICS systems to secure these mission-critical assets.

Business Analytics: Organizations can apply machine learning algorithms against the machine data created by industrial control systems to increase productivity, uptime and availability. ICS data can also drive visibility into complex manufacturing processes, helping identify bottlenecks and remove inefficiencies.

Security & Compliance: Industrial control systems play a critical role in delivering services to industry and municipalities across the world. These systems live on top of traditional IT infrastructure and – while typically separate from enterprise IT – digital transformation is driving organizations to provide connectivity to these systems, increasing exposure to attacks. These systems tend to be unmanned from a security perspective. Regardless of how ICS might get attacked or infected, data from ICS devices can provide visibility and can be used to analyze and identify malicious activity and potential threats. This visibility enables companies to measure impact and risk, and associate them with business processes.

WEARABLES

Use Cases: Internet of Things, Business Analytics
Examples: ARM, Intel, Lenovo, Microsoft, Samsung



From smartwatches that double as fitness aids to medical devices that enable physicians to remotely monitor vital statistics, wearable devices have proven they are here to stay. Wearable devices are one of the most recognizable parts of the Internet of Things.

Use Cases:

Internet of Things: Beyond merely syncing with smartphones, the latest generation of smartwatches is taking advantage of geo-positioning systems and application programming interfaces to give device owners an optimal application experience that includes both their location and often time of day.

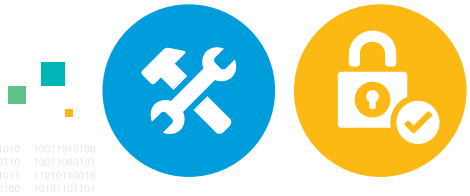
Going forward, there soon will be whole new classes of wearable devices taking advantage of everything from virtual reality applications delivered via a headset to sensors embedded in the latest fashion. Use cases include IoT security to ensure that wearable data is secure and personal information is not compromised.

Business Analytics: As more people become comfortable with sharing data via wearable devices, many are experiencing the power of analytics firsthand. Developers of applications optimized for wearables are making recommendations concerning everything from how to improve life expectancy to where to find a meal. Analytics from wearables can help improve user experience and drive product innovation. For example, product managers can understand how consumers are interacting with devices to build better features.

DATABASE

Use Cases: IT Operations, Application Delivery, Security & Compliance
Examples: MySQL, Postgres, Other Relational Databases

ADDITIONAL DATA SOURCES



Databases are the fundamental elements of information collection, storage and analysis of digital information. Databases are categorized as either relational, in which data is organized in spreadsheet-like tables of columns and rows, or NoSQL (non-relational), where information is organized purely by columns (column store) as key-value pairs, by unstructured documents or interconnected graphs linking related data elements.

Use Cases:

IT Ops & Application Delivery: Database logs can be aggregated and analyzed to show the overall performance of a particular database system, and also provide visibility into database issues. Metrics useful to IT operations teams include queries per second and query response time, both measured against a baseline standard made from historical data.

Security & Compliance: Database logs provide security teams information about the accounts or systems accessing tables or other database elements. Correlating database access and transaction logs with identity management system records can flag unauthorized access or access attempts to databases. Database logs can also expose security holes such as open ports or dormant, unused admin accounts, and help identify abnormal queries or users, and abnormal database/table access.

THIRD-PARTY LISTS

Use Cases: Security & Compliance
Examples: Threat Lists, OS Blacklist, IP Blacklists, Vulnerability Lists, Google Analytics

One of the methods that IT security vendors use to detect and flag security problems is one or more database of known threats and vulnerabilities. These include malware code signatures, OS and application patch versions, the source IP address of previous attacks and spam and reputation databases using real-time aggregation of malware, spam and compromised websites collected from millions of users. Third-party lists provide an early-warning system for new methods or sources of attack.

Use Cases:

Security & Compliance: By aggregating data from users around the world, third-party security lists provide security teams with real-time information about nascent threats and vulnerabilities that allow updating security policies, firewall rules and vulnerable software before an attack. Lists also are used to identify known sources of spam, both commercial and malware-infested, to improve the effectiveness of filters on internal email systems.

SOCIAL MEDIA FEEDS

Use Cases: IT Operations

Social networks are some of the most heavily trafficked sites on the internet. By allowing users to communicate and share information among friends and colleagues, social media has become an important outlet for news, entertainment, photo-sharing and real-time reaction to public events. As such, social media feeds are an increasingly effective advertising medium and source of customer contact, feedback and support.

Use Cases:

IT Ops: Due to their interactivity, convenience and ubiquity, social media feeds provide organizations with an unfiltered and instantaneous view of customer opinion. By analyzing feeds from the most popular sites, organizations can quickly identify potential problems with a product or service, mishandled customer support incidents or other sources of customer dissatisfaction about an organization's products or online presence. Proactively addressing these online complaints allows the organization to turn unhappy and potentially lost customers into delighted and loyal ones.

HUMAN RESOURCES

Use Cases: Security & Compliance
Examples: BambooHR, Fairsail HRMS, Namely, Zenefits

Human Resources records include information relating to the entire employee life cycle. HR records provide the definitive source of employee information for identity management systems and enterprise directories, making them an important source for authentication and authorization data. Although HR data traditionally has been textual, it increasingly includes images and biometric information such as an employee's portrait, fingerprints and iris scans.

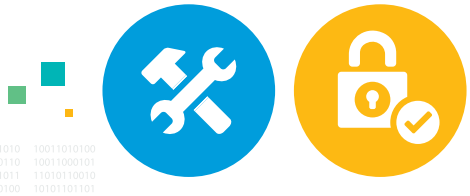
Use Cases:

Security & Compliance: HR records can show if someone no longer employed still has active accounts, and can also provide evidence of disciplinary action that might be useful in security investigations.

BUSINESS SERVICE TRANSACTION & BUSINESS SERVICE PERFORMANCE DATA

Use Cases: IT Operations, Application Delivery, Security & Compliance
Examples: Payments Status, Batch Upload Status, Customer Order Status

ADDITIONAL DATA SOURCES



Transaction records provide an auditable trail of activity for every part of every business process. Whether for financial transactions such as payments and orders, or tasks such as customer support and service calls, business process logs are required to verify activity in case of disputes, to certify compliance with regulations and terms of service, and to provide detailed evidence of business transactions. A technique called business process mining uses sophisticated software to analyze logs and identify process, control, data, organizational and social structures. These might include mapping the flow of patients through a hospital or customer problems through a support organization to optimize process flow, measure performance and identify outlier incidents for further investigation.

Use Cases:

IT Ops & Application Delivery: IT can use process logs to identify flaws in their support or admin processes, or problems that have fallen through gaps in existing process flows.

Security & Compliance: Hackers are good at covering their tracks by altering common log files, but business process logs that track activity across multiple systems used in a particular process can highlight anomalies that may indicate security issues.

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