



## **Matthew Rounds**

*Engineer, Project Manager*

Matthew Rounds is a project manager at Ridgetop Group leading the development of Sentinel Network™, a prognostic health management technology to reduce support and maintenance costs of IT networks. He is also actively involved in the development of prognostic reasoners for IT networks and aerospace projects extracting fault-to-failure signatures. Mr. Rounds has years of industry experience and worked as a research engineer for an IC design company before joining Ridgetop Group. He holds a BS in Engineering Mathematics from the University of Arizona.



The top banner features the Ridgetop Group logo on the left, which includes the text "Ridgetop Group INC" in a bold, italicized font and "ENGINEERING INNOVATION" in a smaller, spaced-out font below it. To the right of the logo are three overlapping images: a white SUV, a military helicopter, and a satellite in space.

**Ridgetop Group** INC  
ENGINEERING INNOVATION

# Overview of Prognostics and Health Management in the IT Industry

Presented by Matthew Rounds

March 21, 2012

# About Ridgetop Group, Inc.

- **Innovative Research and Technology Firm**
  - Incorporated in 2000, and headquartered in Tucson, AZ
  - Design services, prognostics and condition-based maintenance (CBM) solutions
    - AS9100-C and ISO 9001:2008 Certified
    - DO-178 and DO-254 compliant quality system
  - Servicing Aerospace, Automotive, Industrial, Medical segments
  - U.S. Government: U.S. Department of Defense, Department of Energy, and NASA customers



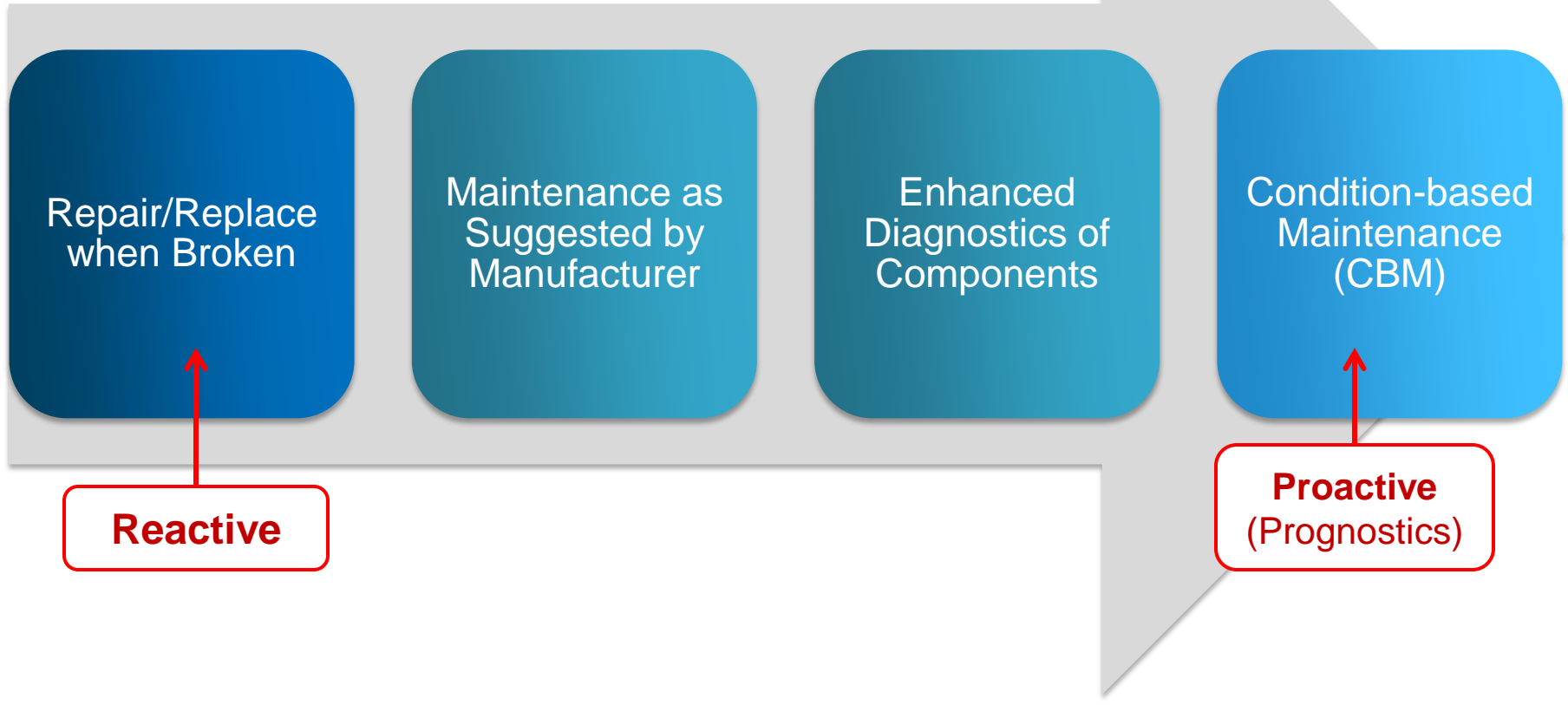
# Agenda

- **Introduction to Prognostics**
- Network Health Management Past and Present
- IT Prognostic Reasoners and Sensors
- Application of Prognostics to an Afloat Network



# Evolution of Network Management

Going from REACTIVE to PROACTIVE/PREEMPTIVE



# Prognostics Definition



Remaining Useful Life (RUL): The amount of time a component can be expected to continue operating within its given specifications (**not necessarily a failure**). Dependent on future operating conditions (input commands, environment, and loads).

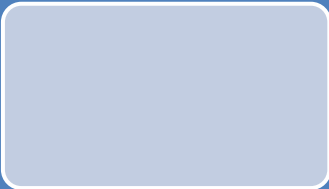


# Goals of Prognostics



## Increase Reliability

- Systems are serviced/replaced prior to catastrophic failure
- Connected systems and subsystems improve performance



## Decrease Collateral Damage

- Avoid cascading effects onto healthy subsystems
- Maintain consumer confidence by increasing availability



## Minimize Logistics Costs

- More efficient maintenance planning
- Reduced spares



## Reduce Unnecessary Maintenance

- Service only specific systems which need service
- Service only when it is needed



# Agenda

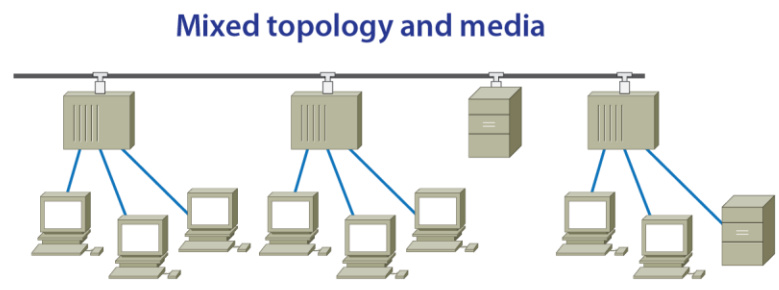
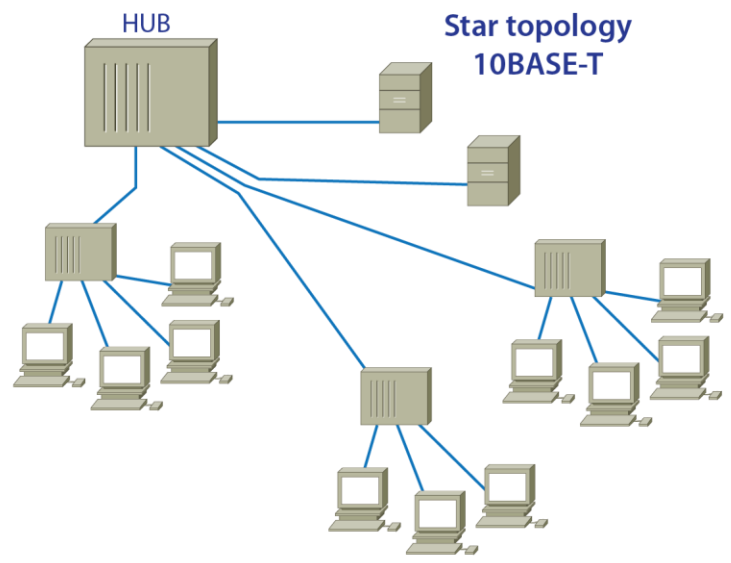
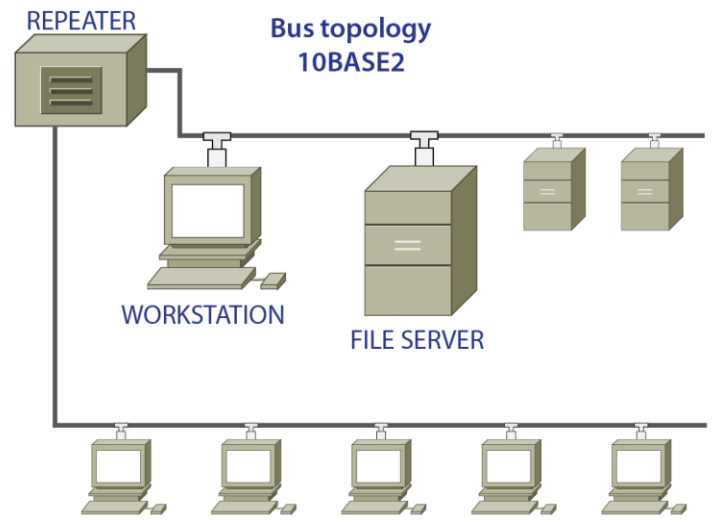
- Introduction to Prognostics
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# Legacy Network Topologies

*A long time ago in a galaxy far, far away...*



# Five Day Network Crisis in a Hospital (2002)

Day 1  
Wednesday

- Network is “flapped”
- IT says this is caused by a CPU spike
- Started to turn off switches to isolate source of the problem, STP loop

Day 2  
Thursday

- Attempted fix was only a fix when no users on the network
- IT HelpDesk flooded with calls from emails to lab work not being delivered
- Cisco CAP deployed, router added to core of network

Day 3  
Friday

- Even with the core of the network upgraded, the network is still flapped
- Hospital network shut down
- Staff return to using paper, the ensuing chaos eventually gave way to a loosely defined routine

Day 4  
Saturday

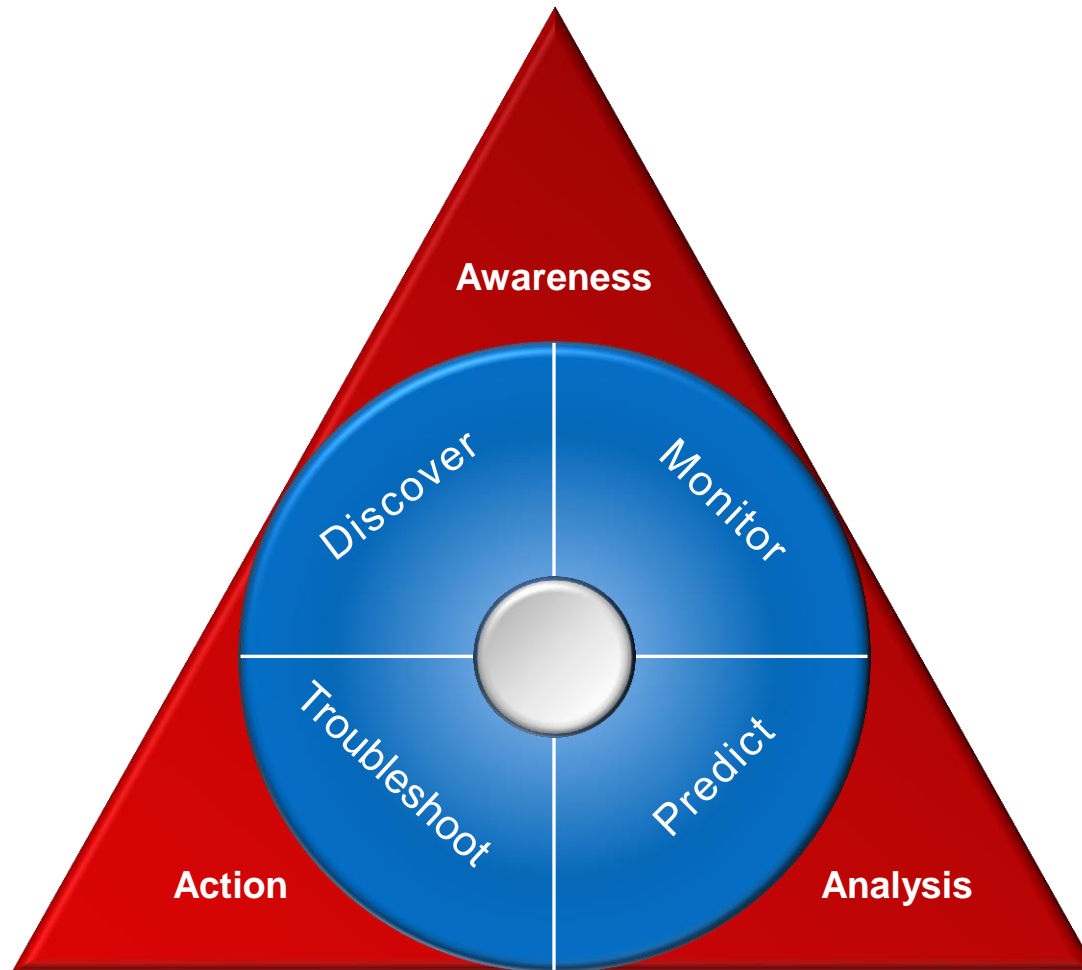
- Two more STP loops found at colocations
- More Cisco equipment brought in and configured for the core network
- Doctors continue to use legacy methodologies to care for patients

Day 5  
Sunday

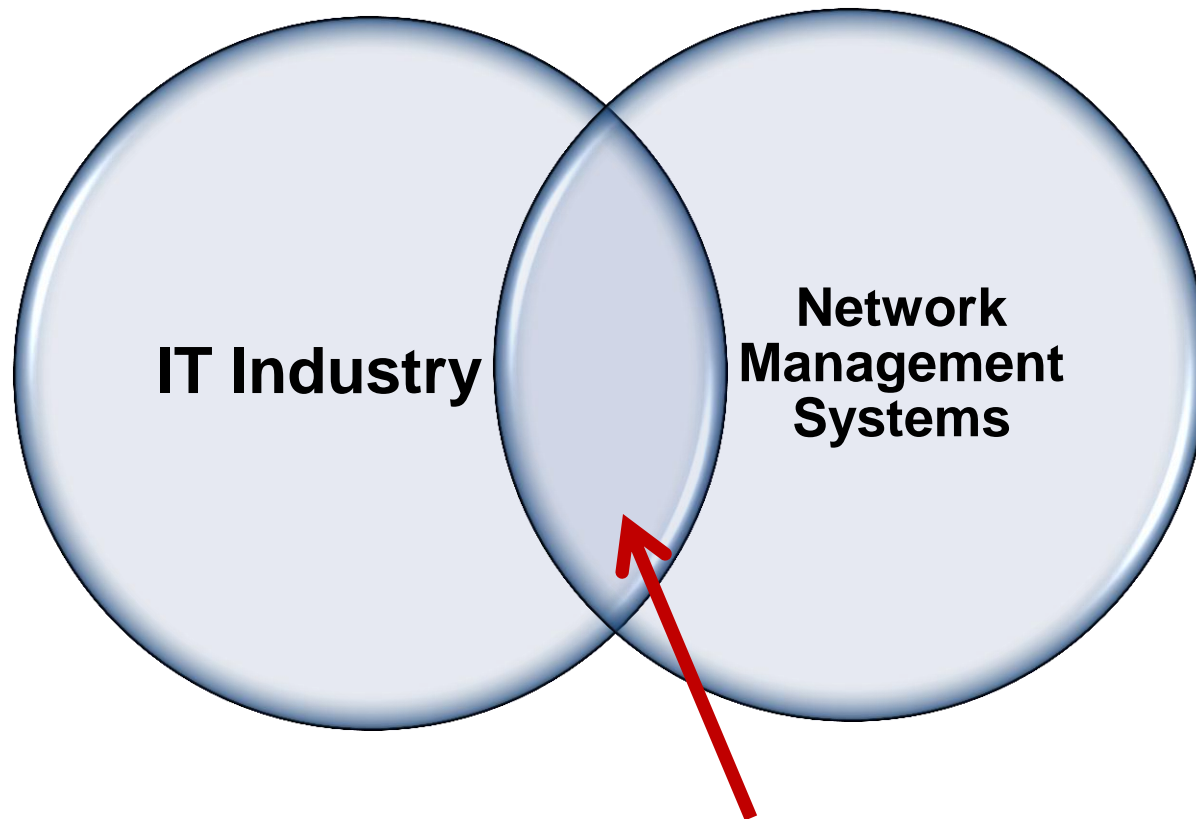
- Another CPU spike occurs with the new core network in place caused by a bad network card in a switch along with a memory leak
- No further CPU spikes, back to business as usual on Monday



# Network Health Management is Needed



# Network Health Management Market



Network monitoring systems market was \$1.33 Billion in 2010 and estimated to be \$1.9 billion in 2015

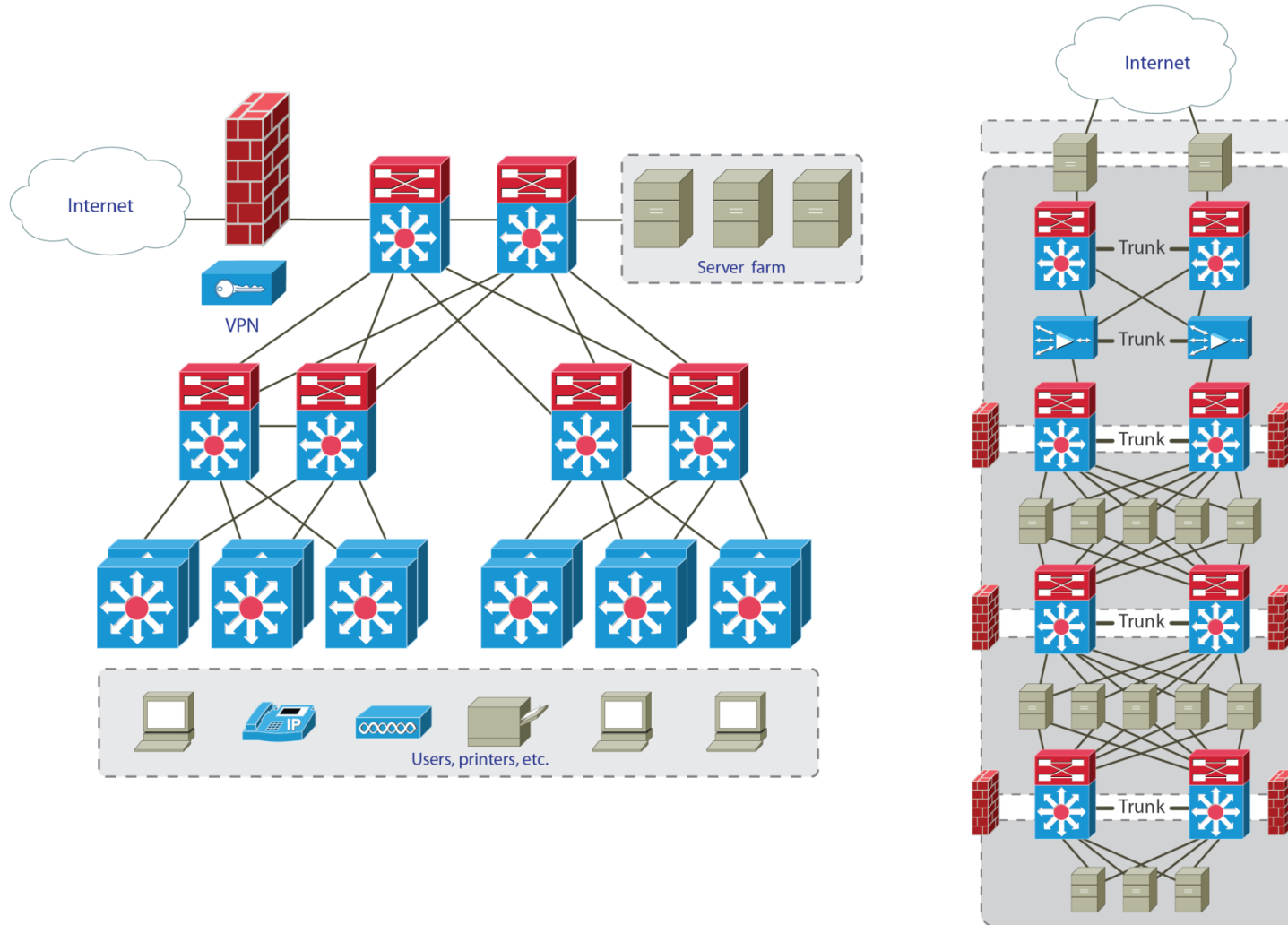
# Current Network Design Criteria

- Tradeoff between security and ease of use for the end user
- Redundancy at the core, edge, and distribution layers
- Backup internet service providers
- Improve network uptime to five nines

Nines	Availability	%	Downtime per year	Downtime per month	Downtime per week
one nine	0.9	90%	36.5 days	72 hours	16.8 hours
two nines	0.99	99%	3.65 days	7.20 hours	1.68 hours
three nines	0.999	99.9%	8.76 hours	43.2 minutes	10.1 minutes
four nines	0.9999	99.99%	52.56 minutes	4.32 minutes	1.01 minutes
five nines	0.99999	99.999%	5.26 minutes	25.9 seconds	6.05 seconds
six nines	0.999999	99.9999%	31.5 seconds	2.59 seconds	0.605 seconds



# Current Network Topologies



# Recent Network Downtime in the News

2012

## Tokyo Stock Exchange

- Trading stopped for approximately three hours
- Cause of the outage was due to a server going down and the automatic failover just plainly did not happen

2011

## Amazon Cloud Outage

- Sites went offline for up to 12 hours
- Cause was due to a router going into an incommunicative state and stopped exchanging routing table information with adjacent devices

2007

## Sloppiness in the Server Room

- Customer service firm (24x7 coverage) down for over three days
- Cause of outage determined to be a broadcast storm and not detectable due to use of unmanaged switches that did not support STP

# Common Network Complaints

- No Internet access
- No email access
- Slow computer
- Can't print
- Can't connect to WiFi
- Can't access files
- Downloads are slow

How can prognostics be used to reduce the occurrence and negative impact of these issues?



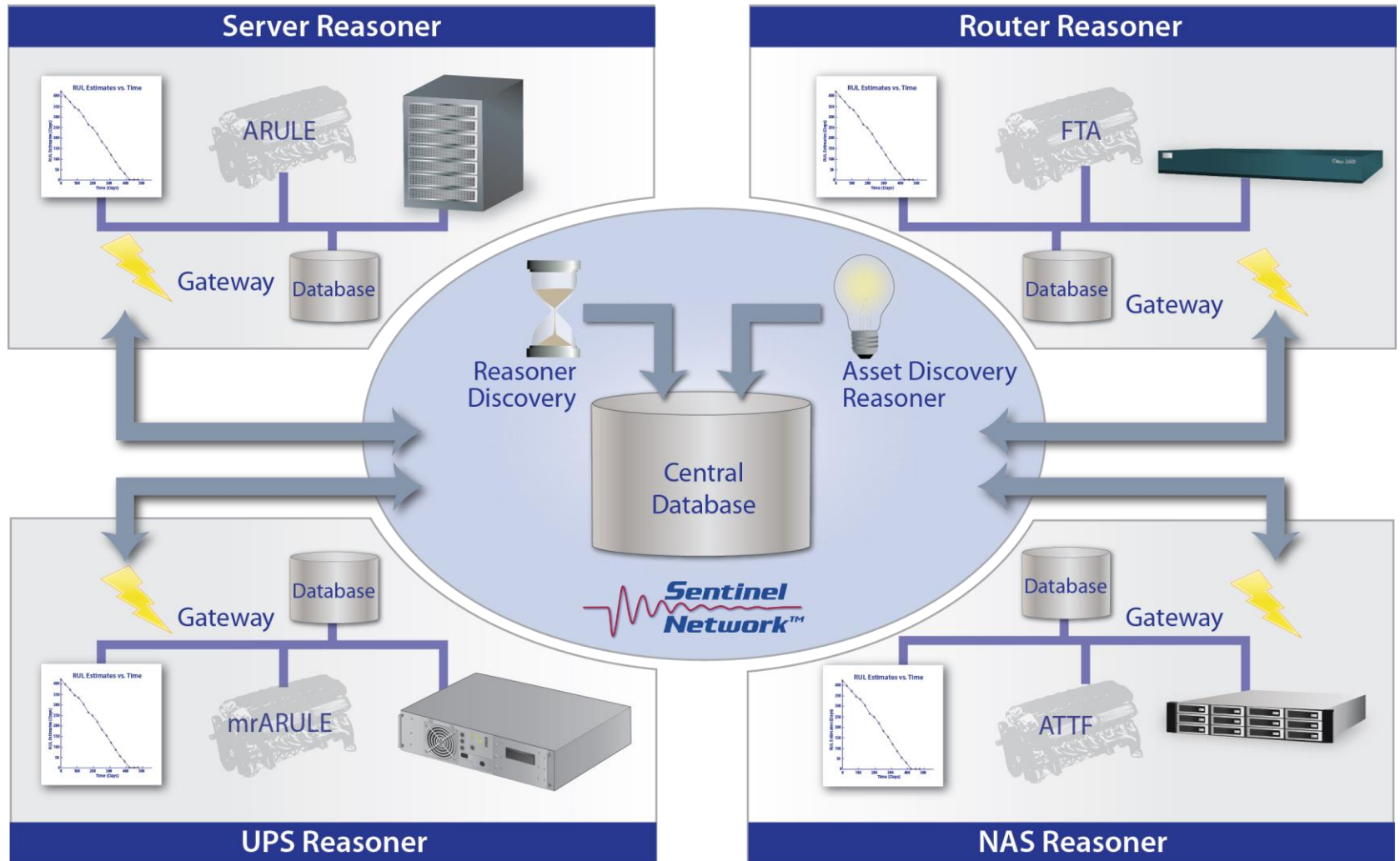


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# PHM Software Architecture Diagram



# General PHM Process

## STEP 1

### Characterize Device or System Failures



Key Failure

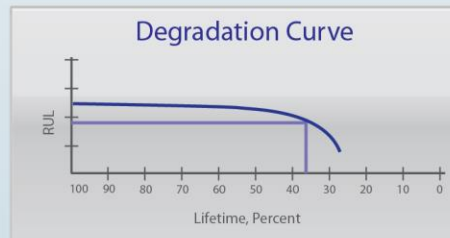
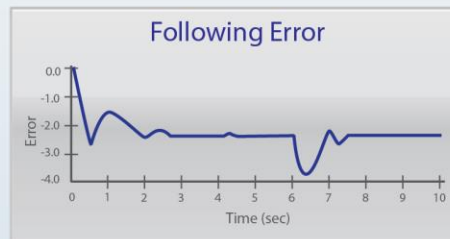
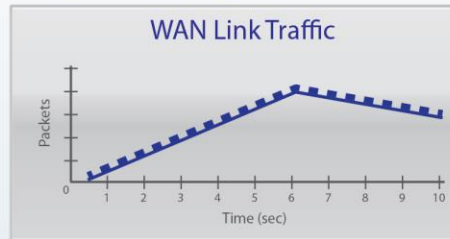


Pareto Ranking of Key Failures

## STEP 2

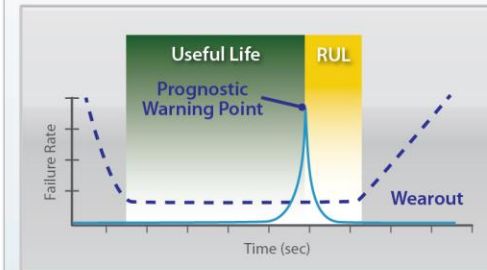
### Extract Precursor Signatures to Failure

Example Precursor Signatures



## STEP 3

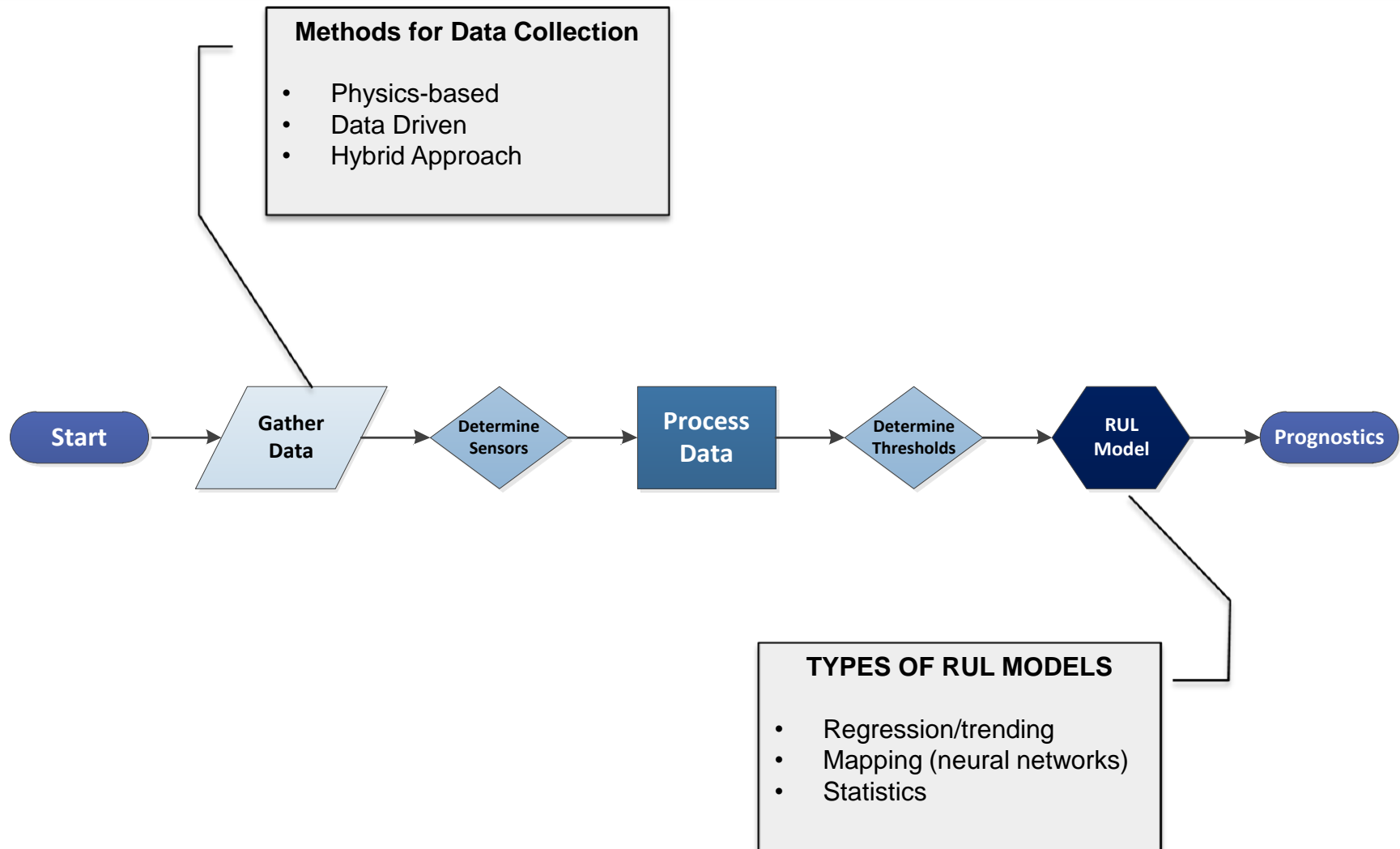
### Calculate Remaining Useful Life (RUL)



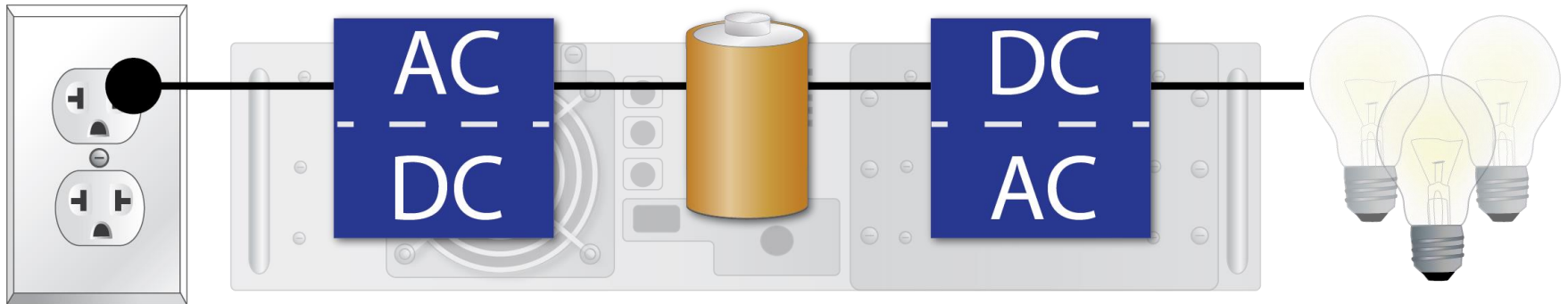
Device or System Lifetime



# Reasoner Development Process

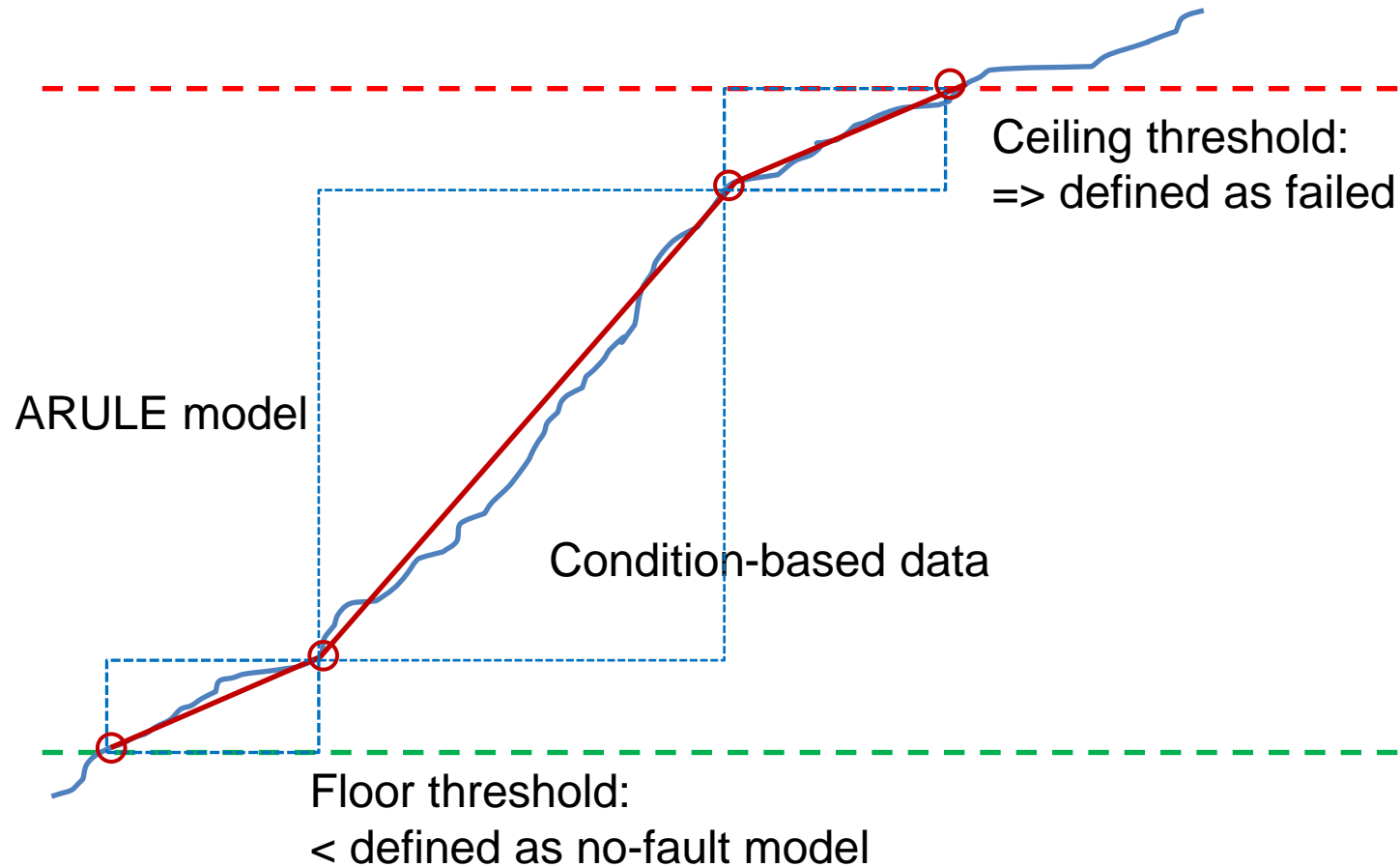


# UPS System Reasoner



1. Conversion from AC to DC (and vice versa)
2. Battery charge and discharge rate
3. Input voltage/current (e.g., brownouts)
4. Variable output load

# UPS System Reasoner - ARULE



# Demonstration of UPS System Reasoner

Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://localhost/index.php?action=flash#

http://localhost/index.php?action=flash#app=db18f5e1-selectedIndex=2

**Sentinel Network™**

Network Management

Logout | Help | About

Asset Properties Real-time Monitor

RUL HealthVIEW EPS Sensor

Warning Critical

Remaining Useful Life (%)

Time

Absolute RUL: 6307168.464095

Alert Hysteresis: 10

Reset

Severity	Date/Time	Host	IP Address	MAC Address	Message
!	2011-08-03 15:08:31	SHIP1-COM-UPS1	10.100.18.2	00.E0.D8.13.63.2D	Remaining useful life less than 60
!	2011-08-03 15:02:32	SHIP1-COM-UPS1	10.100.18.2	00.E0.D8.13.63.2D	State of health less than 60
!	2011-08-03 15:00:37	SHIP1-COM-UPS1	10.100.18.2	00.E0.D8.13.63.2D	State of health less than 80
!	2011-08-03 14:54:57	SHIP1-SEC-UPS1	10.100.21.2	00.E0.D8.13.7D.CA	State of health less than 80
!	2011-08-03 14:53:10	SHIP2-SCI-LPT1	172.16.46.2	00.12.3F.F9.C7.6C	Committed asset unresponsive
!	2011-08-03 14:53:09	localhost	127.0.0.1		Light weight monitoring completed
!	2011-08-03 14:53:01	localhost	127.0.0.1		Light weight monitoring started
!	2011-08-03 14:50:58	SHIP1-SEC-VSRV1	10.100.20.3	84.2B.2B.00.CE.A6	Disk percentage health less than 60

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Version 11.5



# Demonstration of UPS System Reasoner

The screenshot displays the Sentinel Network HealthVIEW interface within a Mozilla Firefox browser. The interface includes a navigation menu with 'Network' and 'Management' buttons, and a 'Logout | Help | About' link. The main content area is divided into 'Asset Properties' and 'Real-time Monitor' sections.

**Asset Properties:** A list of assets is shown, including SHIP1-RTR1, SHIP2-RTR1, SHIP1-SW1, SHIP1-SW2, SHIP2-SW1, SENTINELNETWORK, SHIP1-SEC-VSRV1, SHIP2-SCI-UPS1, SHIP2-SCI-UPS2, SHIP2-SCI-VSRV1, SHIP2-SCI-VSRV2, SHIP2-SCI-LPT1, SHIP2-SCI-LPT2, SHIP1-SEC-LPT1, SHIP1-SEC-LPT2, SHIP1-COM-LPT1, SHIP1-COM-LPT2, SHIP1-COM-UPS1, and SHIP1-SEC-UPS1.

**Real-time Monitor:** The 'HealthVIEW EPS Sensor' section features a line graph showing 'Remaining Useful Life (%)' over time. The graph shows a step-like increase from approximately 10% at 15:11:28 to 100% at 15:12:58. To the right of the graph are two vertical sliders for 'Warning' and 'Critical' thresholds, both set at 60. Below the graph is a gauge showing 'Absolute RUL' at 63072059.924523 and a 'Reset' button. An 'Alert Hysteresis' value of 10 is also displayed.

**Event Log:** A table at the bottom of the interface lists system events with columns for Severity, Date/Time, Host, IP Address, MAC Address, and Message.

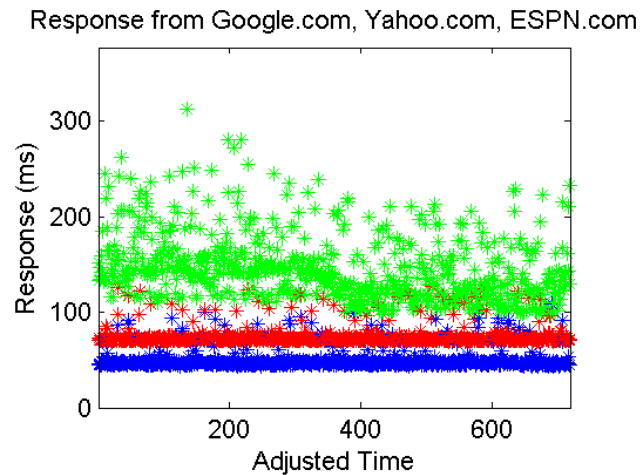
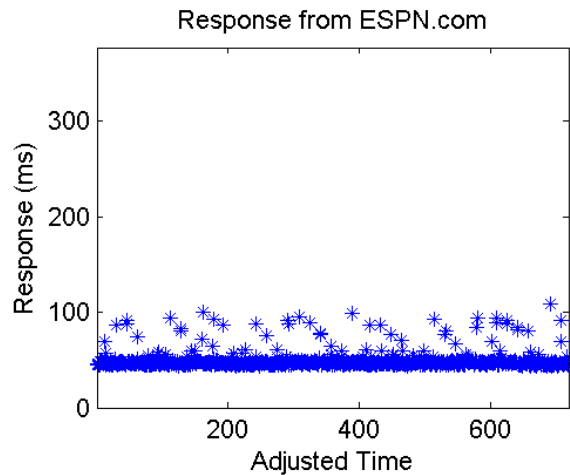
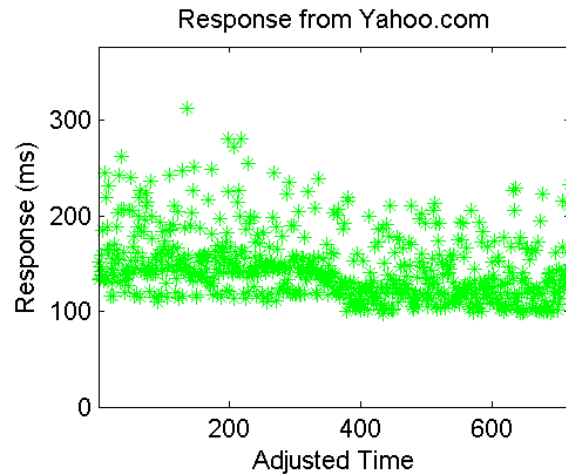
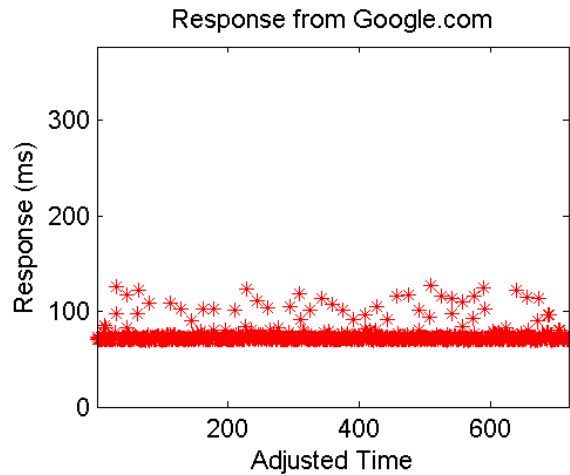
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!	2011-08-03 15:02:32	SHIP1-COM-UPS1	10.100.18.2	00.E0.D8.13.63.2D	State of health less than 60
!	2011-08-03 15:00:37	SHIP1-COM-UPS1	10.100.18.2	00.E0.D8.13.63.2D	State of health less than 80
!	2011-08-03 14:54:57	SHIP1-SEC-UPS1	10.100.21.2	00.E0.D8.13.7D.CA	State of health less than 80
!	2011-08-03 14:53:10	SHIP2-SCI-LPT1	172.16.46.2	00.12.3F.F9.C7.6C	Committed asset unresponsive
!	2011-08-03 14:53:09	localhost	127.0.0.1		Light weight monitoring completed
!	2011-08-03 14:53:01	localhost	127.0.0.1		Light weight monitoring started
!	2011-08-03 14:50:58	SHIP1-SEC-VSRV1	10.100.20.3	84.2B.2B.00.CE.A6	Disk percentage health less than 60

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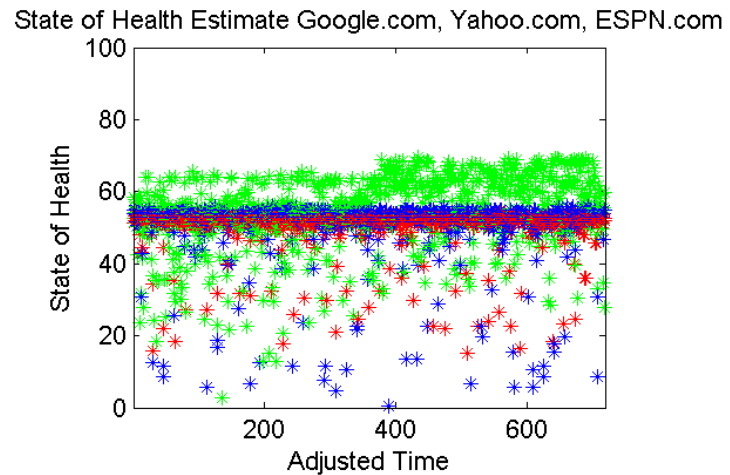
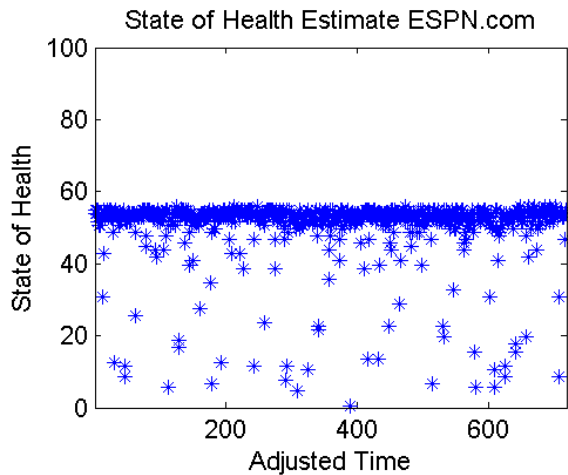
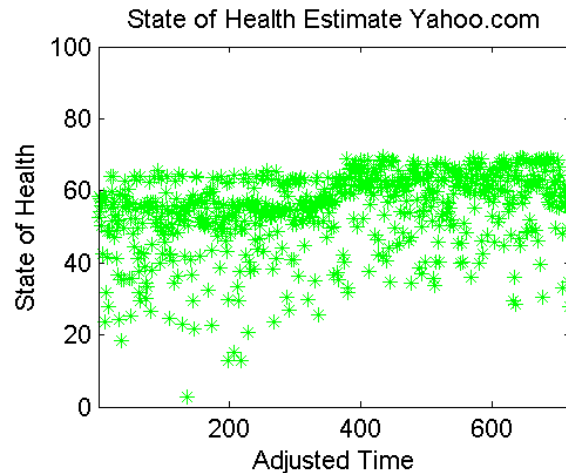
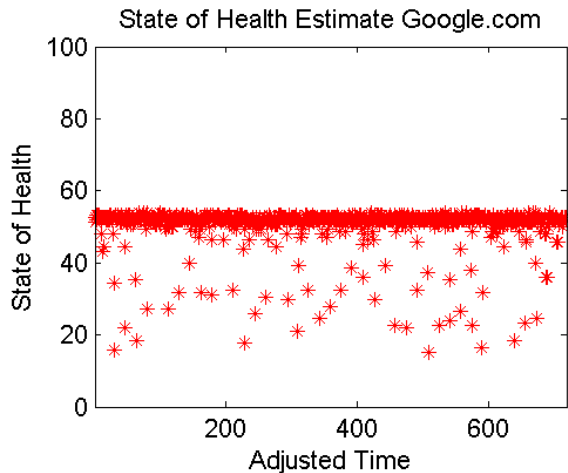




# Internet Interface Reasoner

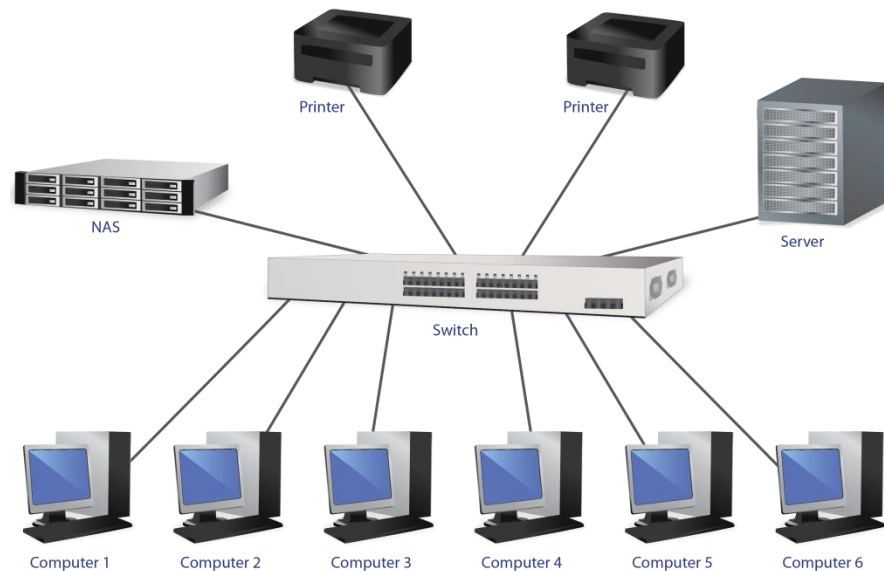


# Internet Interface Reasoner

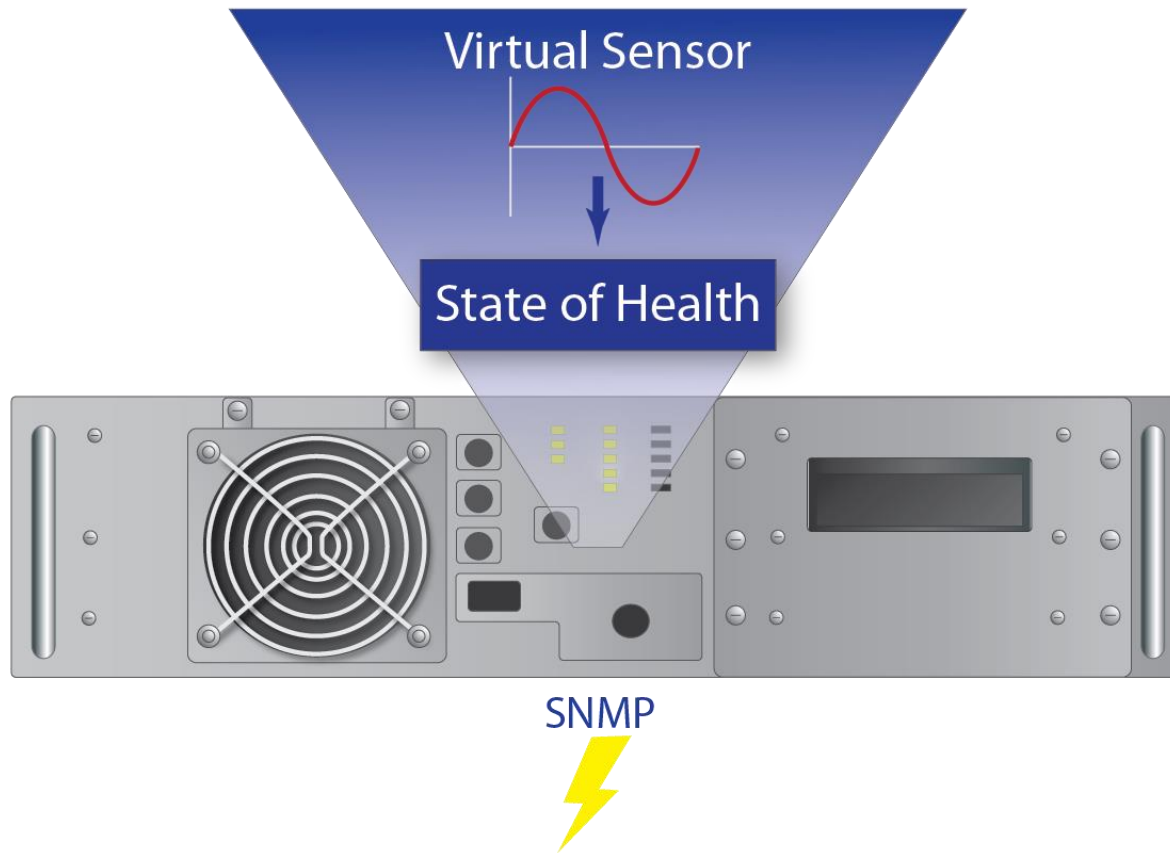


# Technical Writer Group Reasoner

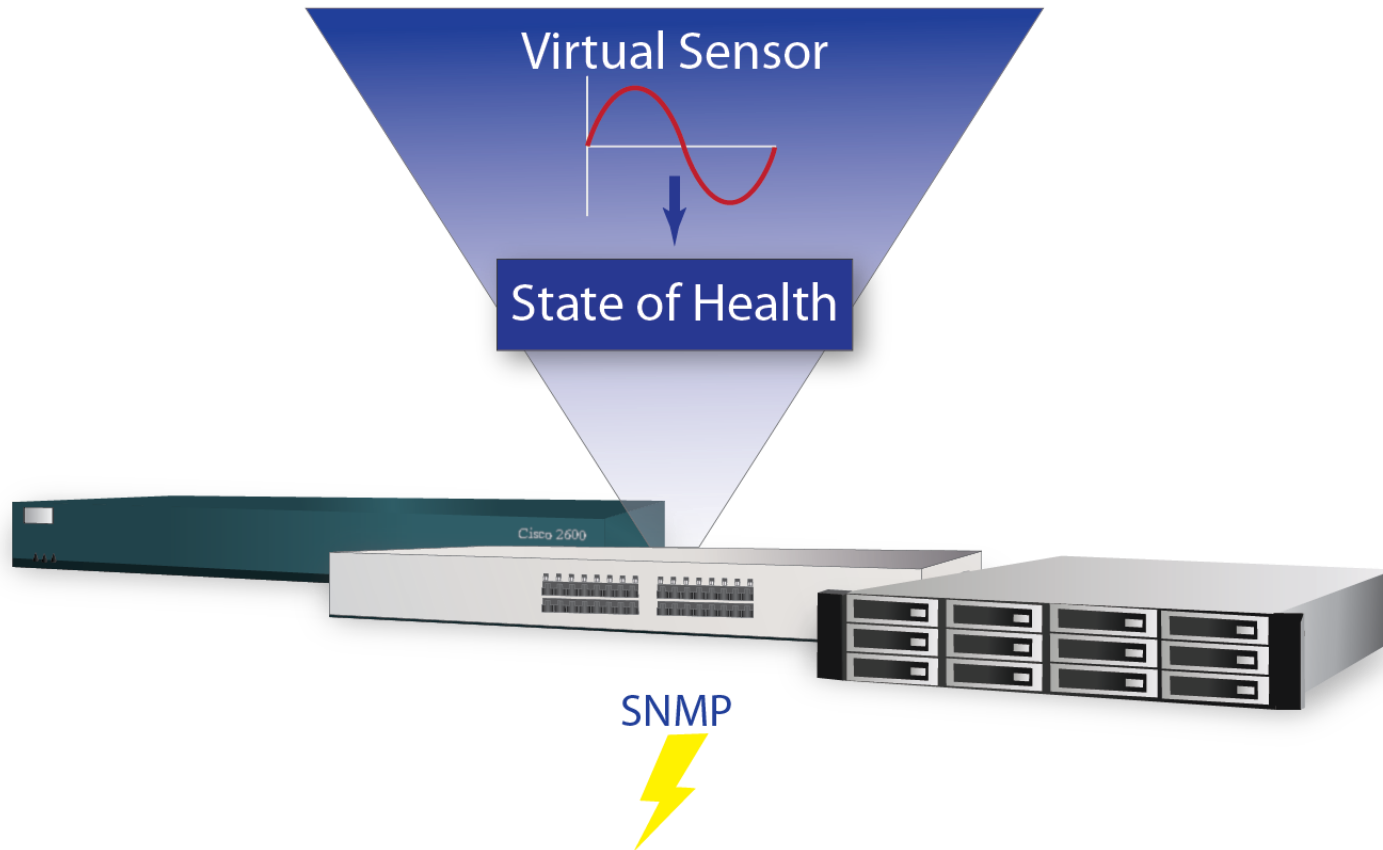
Technical writers use computers, NAS, servers, and printers to perform their daily function. A reasoner can be developed to identify a state of health for this group that is based on disc read/writes, network connectivity, printer status, etc.



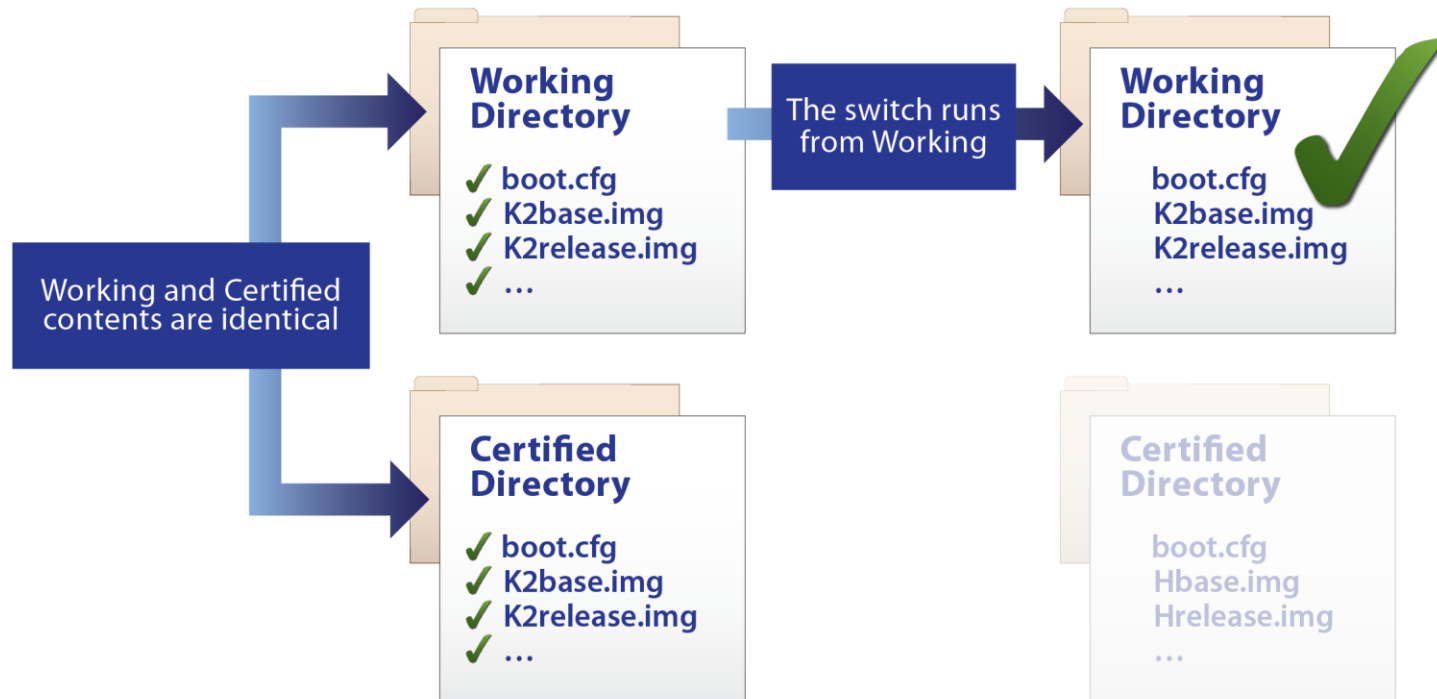
# Future UPS Prognostic Sensor



# Future Managed Device Prognostics Sensor



# Managed Device Directory Structure



# Agenda

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- **Application of Prognostics to an Afloat Network**



# US Navy Afloat Networks

The United States Navy faces the challenge of maintaining a reliable and robust afloat network aboard warships during tactical missions. When failure occurs, while operating in a remote environment, this results in costly and unscheduled maintenance of these systems.



# Sentinel Network Features

## Discovering

- IT Asset Inventory
- Common Network Protocols – SNMP & ICMP

## Monitoring

- Network Configuration Management
- Lightweight & Full Modes
- Add/Remove assets

## Visualization

- IT Device Performance
- UPS Health
- Power System Prognostics

## Troubleshooting

- Switch monitoring
- Switch reconfiguration

## Alerting

- Receive Notifications
- E-mail
- Ignore Recurring Alerts

## Event Logging

- Records Alert Data
- Stores Network Data



# Questions?



# Upcoming Webinars



Topic	Date	Time
ARULE (Adaptive Remaining Useful Life Estimator) – ATTF (Advanced Time-to-Failure) to Diagnose and Predict System Health	Wed. Apr 25, 2012	1:00 - 2:00 PM PDT
IC Characterization with ProChek, a Compact Benchtop System	Wed. May 30, 2012	1:00 - 2:00 PM PDT
Implementation of Prognostics in Solar Applications	Wed. Jun 27, 2012	1:00 - 2:00 PM PDT
Troubleshooting Analysis and Decision Support in Complex Applications	Wed. Jul 25, 2012	1:00 - 2:00 PM PDT

For more information about Ridgetop Group Webinars, email us at [information@ridgetopgroup.com](mailto:information@ridgetopgroup.com)



# Thank You



# References

- <http://itcblogs.currentanalysis.com/2012/03/14/with-network-dependence-critical-is-downtime-acceptable/>
- [http://www.crn.com/news/cloud/231500023/amazon-offers-explanations-apologies-for-dual-cloud-outages.htm;jsessionid=+iZO966cD19VL1VHozq-zQ\\*\\*.ecappj01](http://www.crn.com/news/cloud/231500023/amazon-offers-explanations-apologies-for-dual-cloud-outages.htm;jsessionid=+iZO966cD19VL1VHozq-zQ**.ecappj01)
- <http://www.infoworld.com/t/it-jobs/sloppiness-in-the-server-room-brings-down-the-network-188598?page=0,1>
- [http://www.cio.com.au/article/65115/all\\_systems\\_down/](http://www.cio.com.au/article/65115/all_systems_down/)
- <http://www.computerworlduk.com/news/it-business/3335067/tokyo-stock-exchange-trading-floored-after-server-outage/>
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