DesignKnowledge

Asset Life-Cycle Information Management (ALCIM)
WR-ALC Commodities Manufacturing (CMXG) Operations Support for CBM
8 May

TOP WORK PLACES 2013 Dayton Daily News Springfield News-Sun

Voted The #1 Small Business
In Dayton – 2013

DAYTON BUSINESS JOURNAL BPtW 2017 BEST PLACES TO WORK WINNER

Voted Dayton's Best Places To Work
2012, 2013, 2014, 2015, 2016, 2017 and 2018

THE BEST IN SBIR

National SBIR Tibbett's Award
2007 and 2012

Presentation Outline

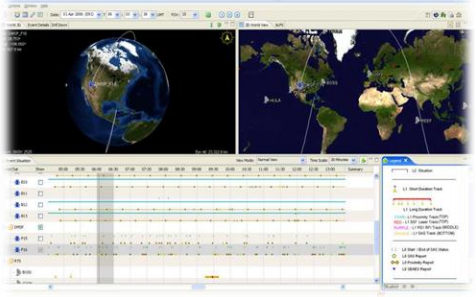
- TDKC Overview and Areas of Expertise
- ALCIM Program Overview and Challenges
- Machine Learning for Condition Based Maintenance
- The "Semi-Disconnected" environment
- Integration

TDKC Core Competencies

- Multi-Domain Situation Awareness Requirements
  - Developing SA tools for Air, Space, Cyber, Logistics, and Civil Engineering
- Navigation Systems
  - Developing tracking tools based on passive sensors for soldier navigation
- Cyber
  - Developing software/architecture/processes for DOD/AF Insider Threat programs
- C4ISR
  - Developed command and control tools for a variety of domains.
- Space
  - Lead developer for JSpOC Mission System UDOP (Program of Record)

TDKC Technology Transition Examples

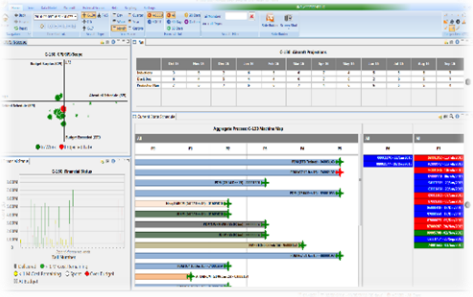
JMS - Space SA (Operational)



- Provides real time space situational awareness and command and control of space forces
- Operational at Vandenberg, AFB for the past 4+ years
- Currently supports over 30 data feeds and 600 users

"JMS represents the keys to the kingdom. Given where we were five years ago, that's remarkable. I just didn't think we'd figure out a way to get through. But we did. It's awesome. It's spectacular." – Gen John Hyten, Commander, AF Space Command

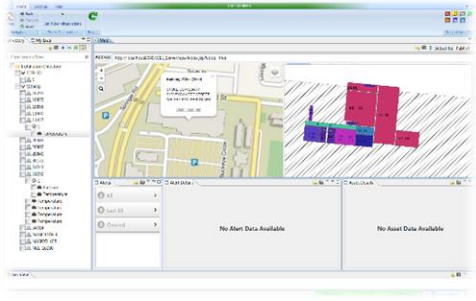
ARViSS – ALC Ramp SA (IATO)



- Provides real time, macro-level view of ALC Ramp process for aircraft repair and redeployment
- Recently granted Interim Authority To Operate
- Currently supports over 22 data feeds and 75+ users

"This is the first time I've had a complete and detailed view of all factors affecting our operation in one place. Our ability to identify and address issues quickly…well, this is awesome!" - Brig Gen Walter Lindsley, Commander, Warner Robins Air Logistics Complex (WRALC)

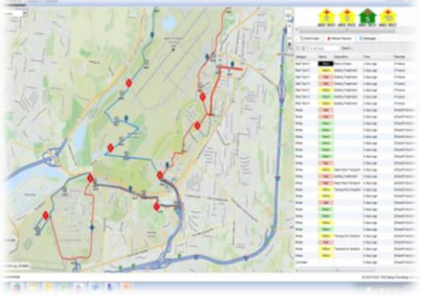
ICEE - Civil Engineering SA (Pilot)



- Provides real-time SA for civil engineering infrastructure.
- Completed a very successful WPAFB Pilot in 2015
- Automates asset visibility, predictive maintenance, lifecycle management and energy reduction

"ICEE is a game changer for AF Civil Engineering." - Mr. Rob Gingell, Chief CEMIRT Division at the Air Force Civil Engineering Center

MOLES - Fire/EMS/Security SA (Pilot)



- Provides collaboration, communication and information sharing across fire, security and volunteers
- Includes COP and mobile app
- 2015 AF Marathon Pilot
- 2016 Events (Corona, AF Museum Expansion, and AF Marathon)

Lt Gen John Thompson, Commander, Air Force Life Cycle Management Center (LCMC) visits the MOLES C2 Trailer during 2015 USAF Marathon

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Proven Success With Innovation and Technology Transition

ALCIM Program Overview

Air Force Warfighter Superiority

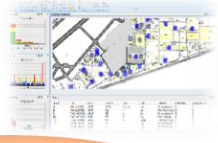
Providing superior depot maintenance, engineering, and development for major weapon systems




Leveraging SBIR Investment | **Delivering Advanced Capability**

Asset Life Cycle Information Management (ALCIM) STTP

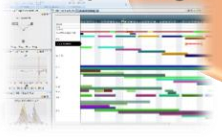
Adaptable Analysis & Visualization



Status Reporting

ARViSS TECHNOLOGY

Re-planning



Quality Control

Workflow/Automation

VALUE PROPOSITON:

ALCIM will provide much-needed situation awareness of machine assets to drive preventative maintenance and ensure flow.

Smart Machine Capability

Shop Floor Support

LifeMeter TECHNOLOGY

Logistics Enterprise Support

LifeMeter Equipment

Depot Interface

ALCIM Program Challenges

- Maintenance of users' complete situational awareness of machine changing multiple times per day based on changing work requirements
- Multiple data systems supplying contributory data
- Creation of unscheduled or specialty repair parts as requested
- CBM: Need for a more consistent approach for identification and resolution of potential scheduled maintenance problems
- Suitable tools to assess the impact of work delays and downtime over the entire process
- The associated difficulty of process throughput optimization, *especially under dynamic conditions* that are part of everyday operations WR-ALC

LifeMeter Integrated CBM/PHM Solution

Modular hardware and software solution incorporating CBM/PHM capability for improved Maintenance & Repair Organizations (MRO) process maintenance and control

Provides process information for improved decision making across operations

All installation decision were driven by FMEA or RCM based decisions to realize the highest ROI on install costs

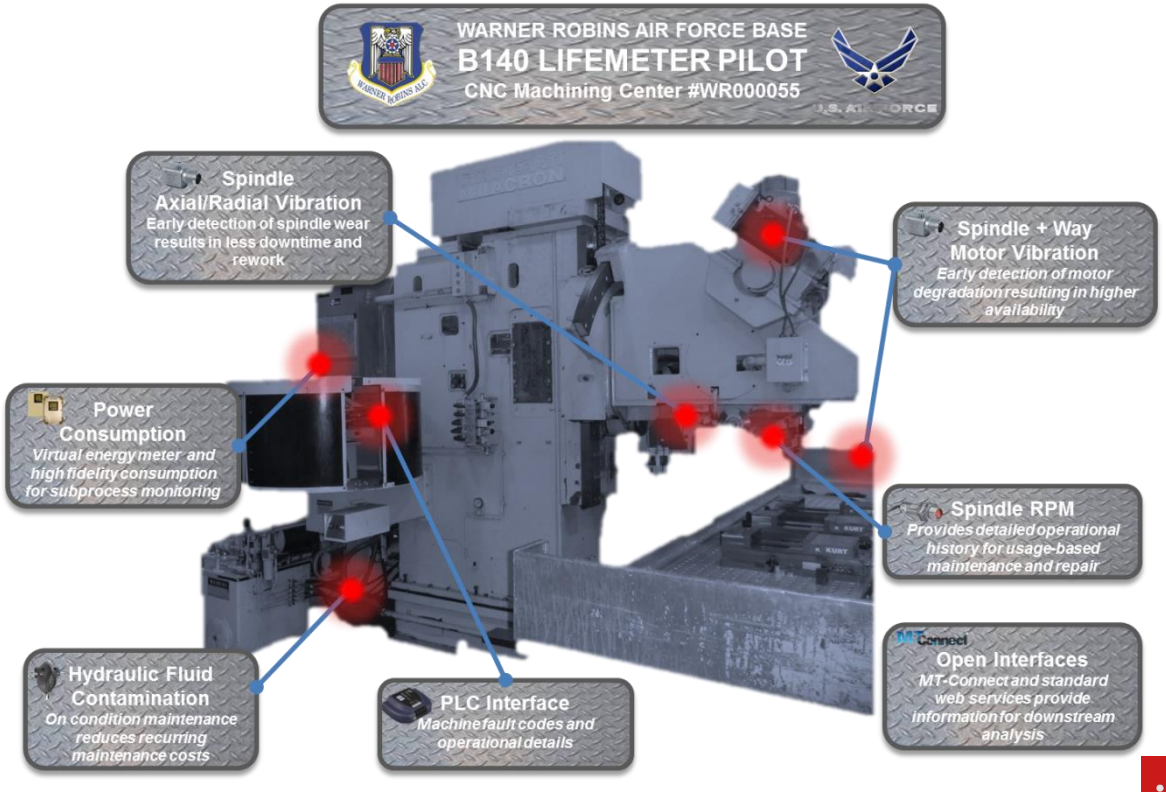
Capabilities:

Production Process CBM

- Machine usage monitoring
- Vibration measurement and analysis
- Energy consumption
- Oil / fluid condition
- Power consumption

Analytics / Decision Support

- Sub-process energy metering
- Asset data dashboard
- Automated work order generation
- Advanced Troubleshooting
- Predictive Scheduling
- Process simulation and optimization



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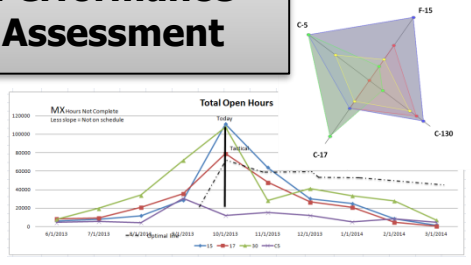
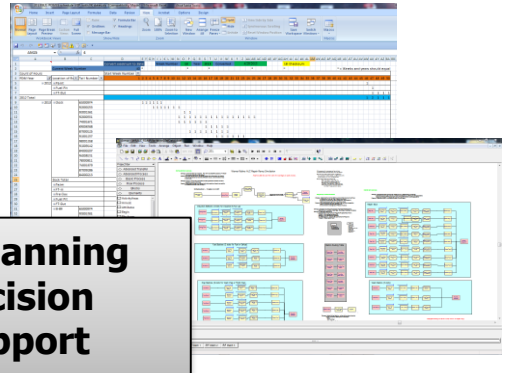
Base: ARViSS Decision Support Application

Ramp Situational Awareness

Dynamic Performance Assessment



ARViSS Users



Re-Planning Decision Support

A User-Centric Comprehensive Environment for Data Integration, Assessment and Ramp Operations Support

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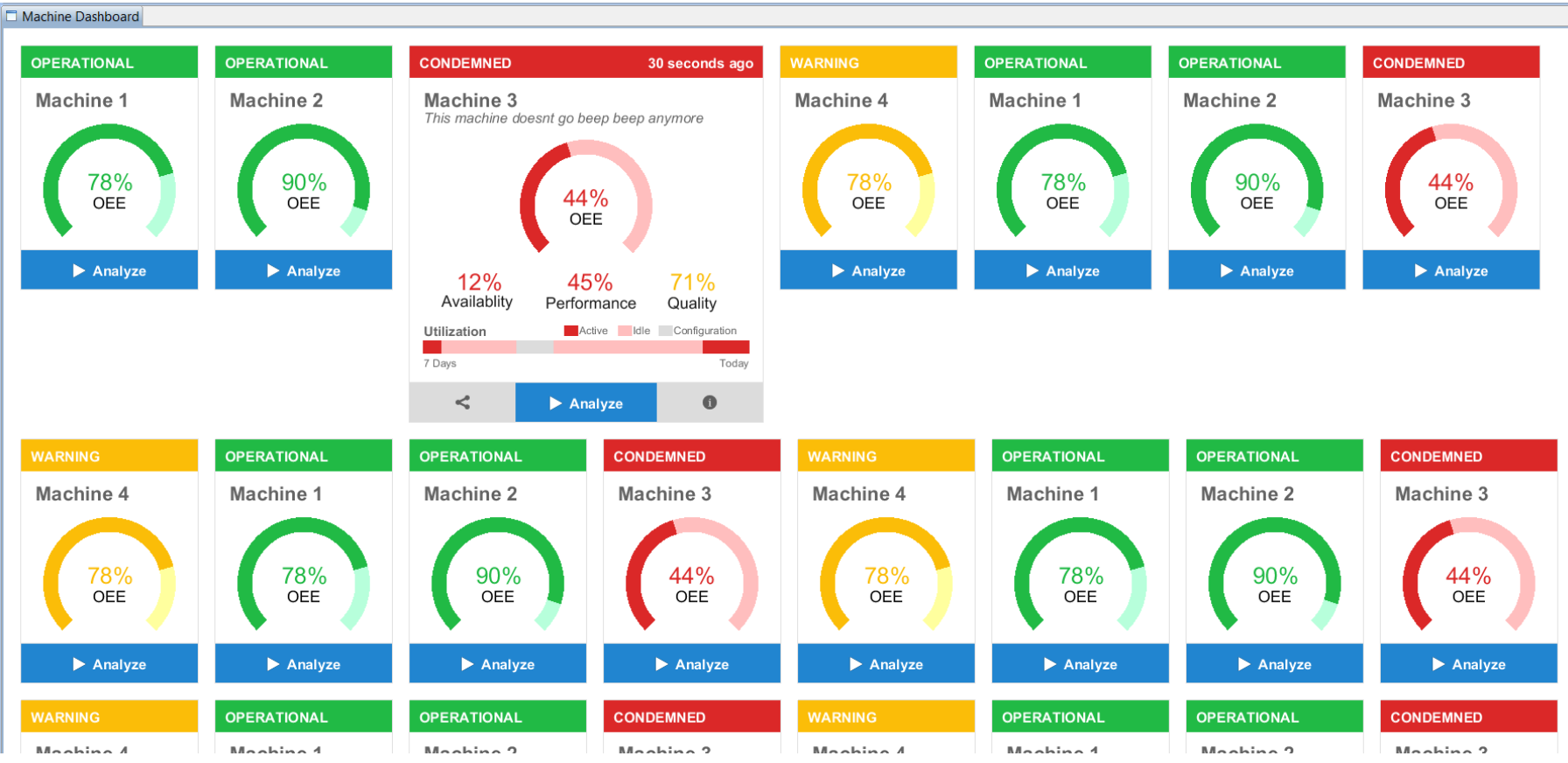
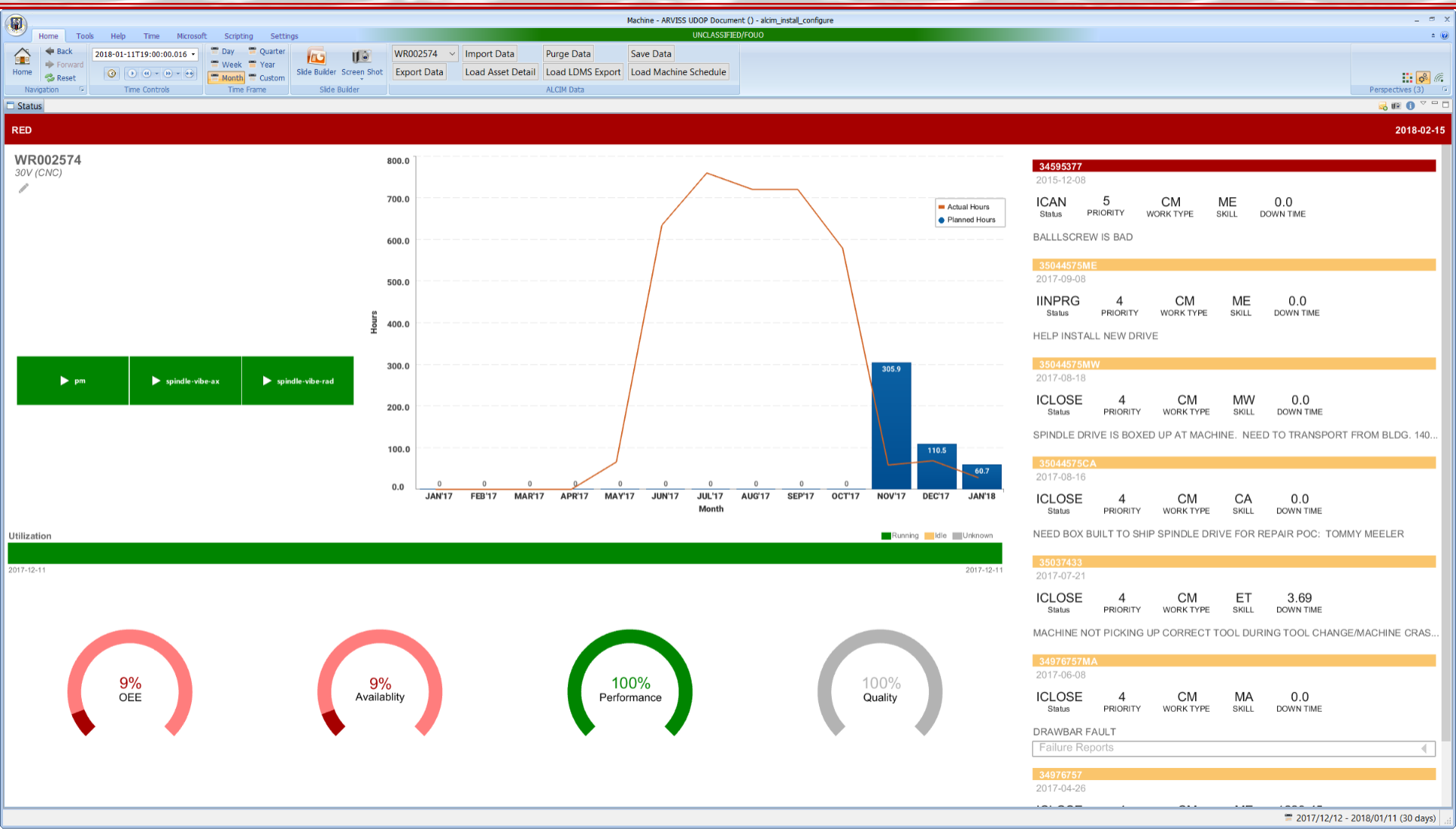
ALCIM User Interface and Functions



ALCIM Machine Drill-Down

Knowledge By Design™



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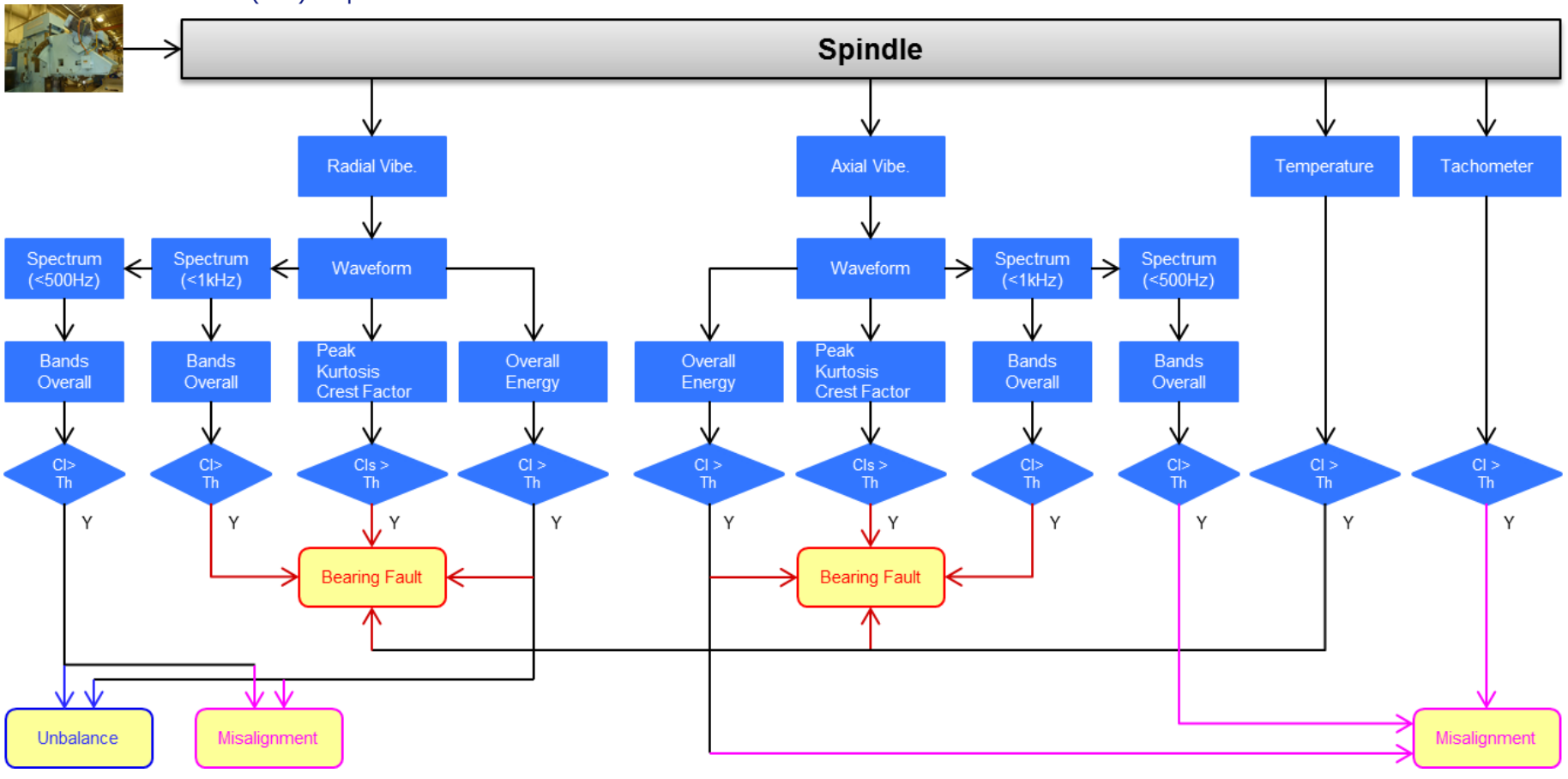
Machine Variables Available for CBM Support

- Power Management: full breakdown of voltages, current demand and summary
- Spindle and motor: vibration, kurtosis, skew, etc.
- Hydraulics: available but not currently used

Data to Information

Vertical 5-Axis Profiler (30V) – Spindle

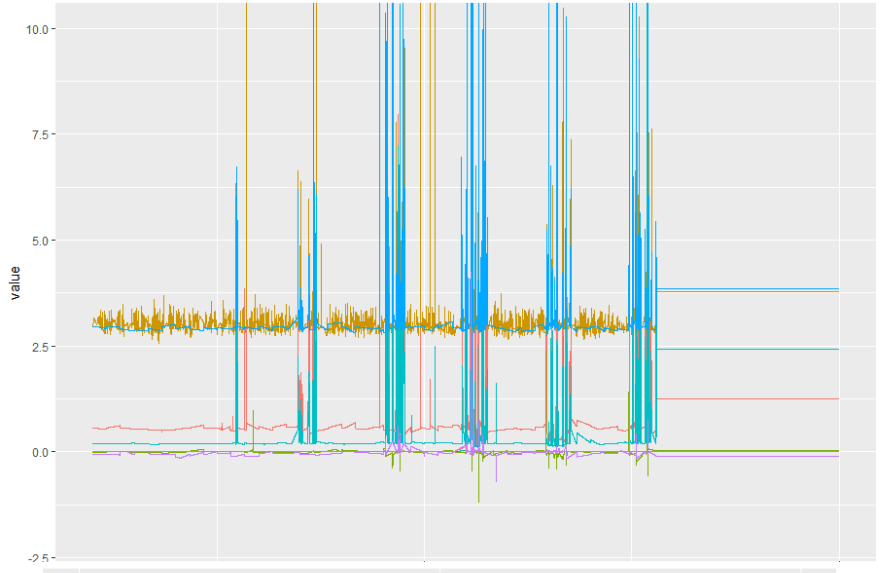


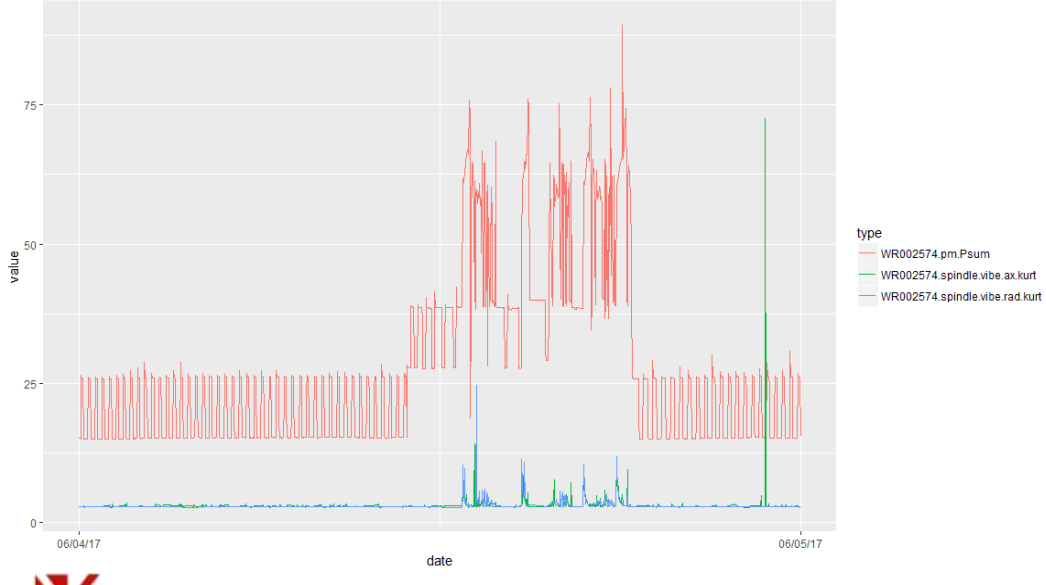
- Fault thresholds from historical (or baseline) data at specific operating modes
- Bearing fault detection using CIs from radial/axial vibrations and temperature
- Unbalance detection using overall energy and bands energy radial vibration spectrum with frequency of less than 500Hz
- Misalignment detection using overall energy and bands energy from radial/axial vibrations and spectra with less than 500Hz and also spindle speed variation at specific operating mode

Machine-Learning for Condition Based Maintenance (CBM)

- Initially "Thumb Printing" of individual machines using LifeMeter for normal operations
- Using: LifeMeter data for power, spindle vibration, kurtosis (simple → more complex over time)
- Produced Support Vector Machine (SVM) discrimination models for power consumption and spindle vibration.

Machine Learning Modeling Results





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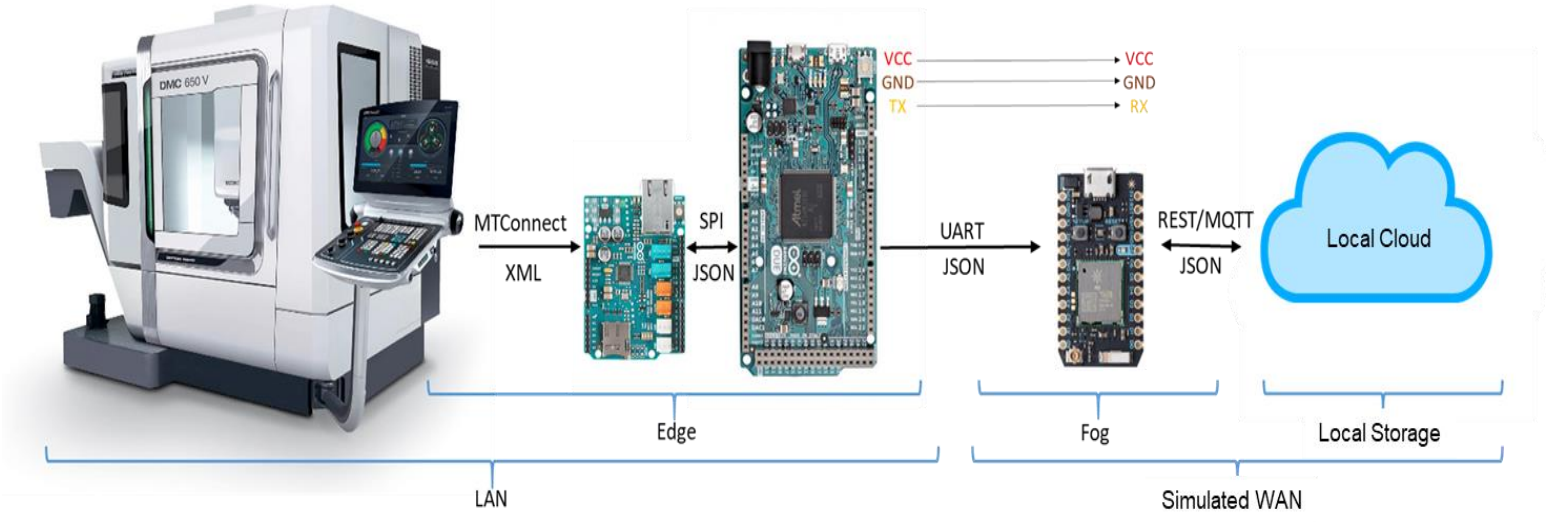
Challenges in Semi-Disconnected CBM Environment

- Compatible with MTConnect and Non-MTConnect sensors and devices
- Communicates with Internet and cloud without the need of static IP address
- Hardware secured between LAN and IAN
- Enables the machines and platforms to directly communicate with one another
- Capable of high frequency data acquisition from standalone sensors
- Facilitates fog computing and cloud computing

(compiled by M. Parto – Ga. Tech. 2017)

Instrumenting CNC with COTS / MTConnect



- Enable non-instrumented CNC (and other machines) to be integrated into ALCIM with LifeMeter instrumented machines seamlessly
- Low-cost COTS Componentry: Raspberry Pi, Particle Photon, Beagle Board Black
- Uses MTConnect for device independence to JSON for compression, can be served externally to fog or cloud – subject to security concerns

Summary

- Successful project under way to link:
  - Scheduling
  - Machine programming
  - Machine health data from instrumented and non-instrumented machines
  - Actual production data
- Machine learning "thumb printing" models produced
- Many challenges in disconnected, secure environment
- Anticipate managed machine maintenance cycles using ML prognostics models