KGA - MARCH 14, 2023

SCADA State of the Union

Where we’ve come from and where we’re going

Jake Hawkes, Snr. Product Manager, Enterprise SCADA

AVEVA

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Introductions

Venezuela, 2001

Mexico, 2004

Egypt, 2008

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SCADA in the Past

A trip down memory lane

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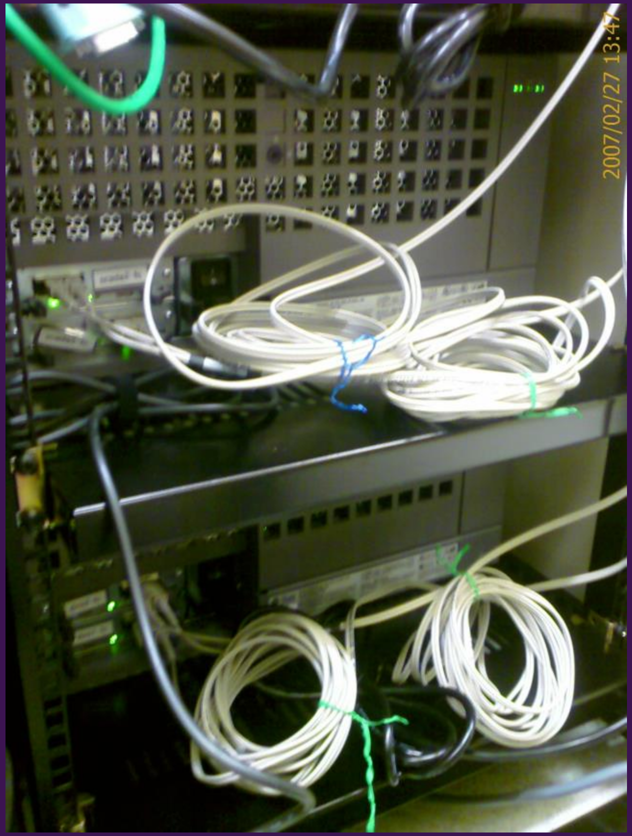
SCADA: Mainframe to PC

A brief history

- Everything was on bare metal
  - UNIX was dominant
  - As computing power increased, so did the capability of the SCADA mainframe
- Early adopters of new technology
  - SCSI → Fiber Channel → iSCSI
  - Internal storage → External SCSI RAID → NAS/SAN
- Enterprise SCADA (formally OASyS) was one of the first to transition to Windows.



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SCADA: Communications

A brief history

- Serial communications
  - Pre-internet, this was the only way to communicate
  - Multi-drop serial lines were a cost-effective way to extend the use of the infrastructure
- Large infrastructure investments
  - Needed if no leased line or dial-up available
  - Build and maintain microwave and P2MP radio networks
- Redundancy was crucial
  - Digital bridges & dual terminal servers
  - Required specialised software to drive it all
- TCP/IP and VSAT came later
  - TCP/IP revolutionised the server room
  - As it rolled out to the field, the complexity of the solution reduced

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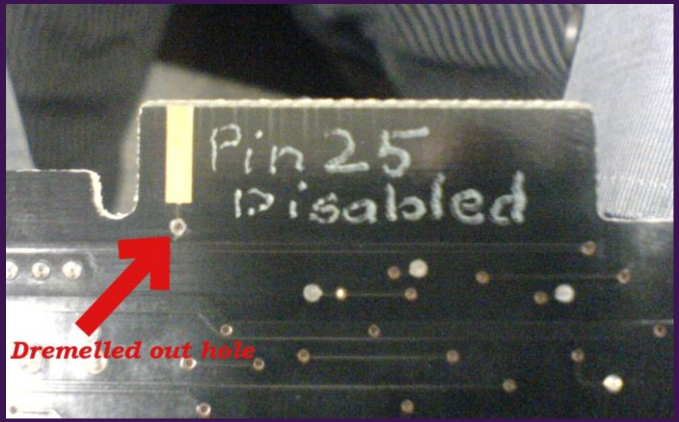
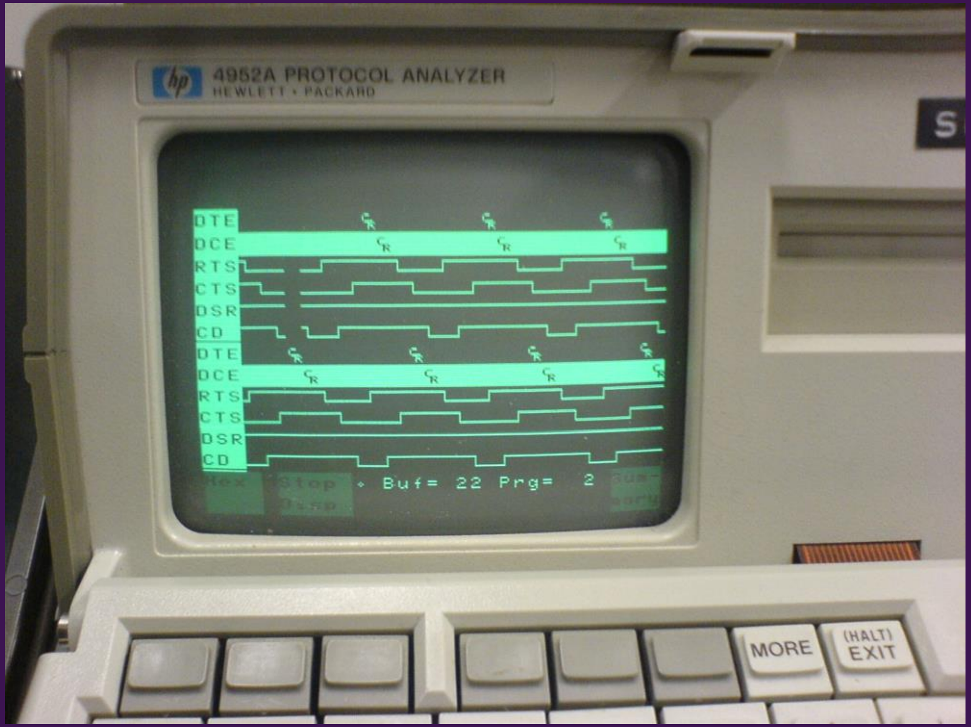
SCADA: Protocols

A brief history

- Very few standardised protocols
  - Most were reverse engineered
- Developers needed hardware expertise
  - Having a Computer Systems Engineering degree came in very helpful

Beware the programmer that carries a screw driver. Or in this case, a Dremel





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SCADA: Scaling up

A brief history

- Just add more servers!
- Growing desire to keep everything centralised
- Software had to evolve to keep them all in sync

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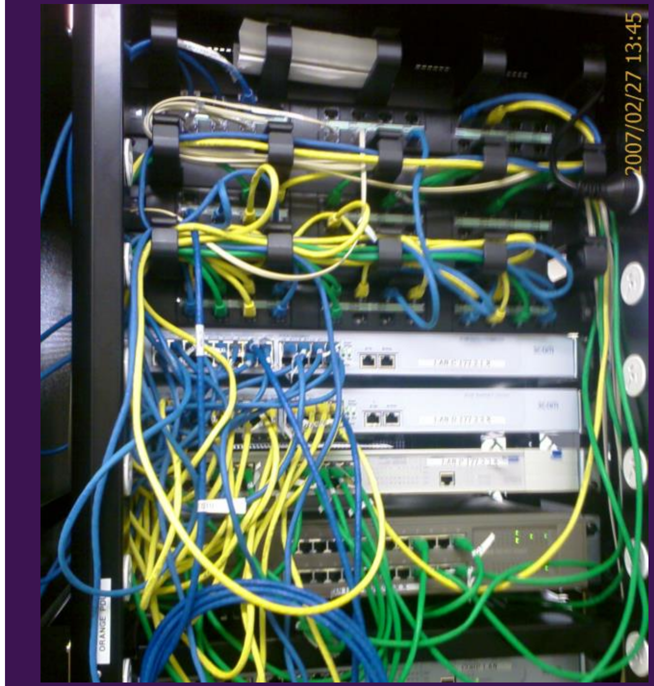
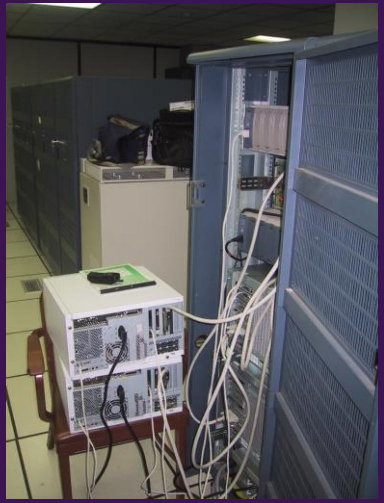
SCADA: Change Management

A brief history

- Wasn’t important, or so we thought
  - Embraced the improvisational mind-set
  - Experts adapting to evolving needs on the fly
- Get the customer back up at all costs
  - Going back to pretty things up was seen as a luxury
- Relied on having experts that could go anywhere any time
- Hard to achieve 5x9’s





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SCADA: Change Management

A brief history

- New assets require new SCADA configuration
- Manual process, high risk
  - Obtain entire PLC read out, hope it’s the latest version
  - Go through and pick what the control room needs
  - Argue with PLC programmers about 0-based registers
  - Develop SCADA configuration
  - Hand enter it all, or bulk load if you’re lucky
- Point 2 point commissioning was essential
  - Would find many issues
    - Off by one
    - Inverted bits
    - Incorrect number conversions

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SCADA: OT Scope

A brief history

- IT versus OT
  - SCADA was at full speed before computers appeared on everyone’s desk
  - The OT group were self sufficient
  - IT didn’t always understand mission-critical systems
  - OT treated SCADA like a giant PLC
- Turn-key projects
  - Large scale projects were common
  - Started with buildings and power
  - High risk, low margins

Repairing a UPS at 3am with help from my driver.
Egypt, 2007

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System Design

Industry Trends

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Project Trends

Increased IT involvement

- Customers have their own O/S images
- Customer’s IT review system design
- Customer’s IT involved in deployments

Less Custom Design

- With more functionality in the product, the need for design documents has been greatly reduced
- Almost all protocols are product extensions and not altered on project

Security

- Product has eliminated non-domain usernames and passwords
- Product fully complies with higher security zones initiating connections
- Proactive security assessments are surfacing

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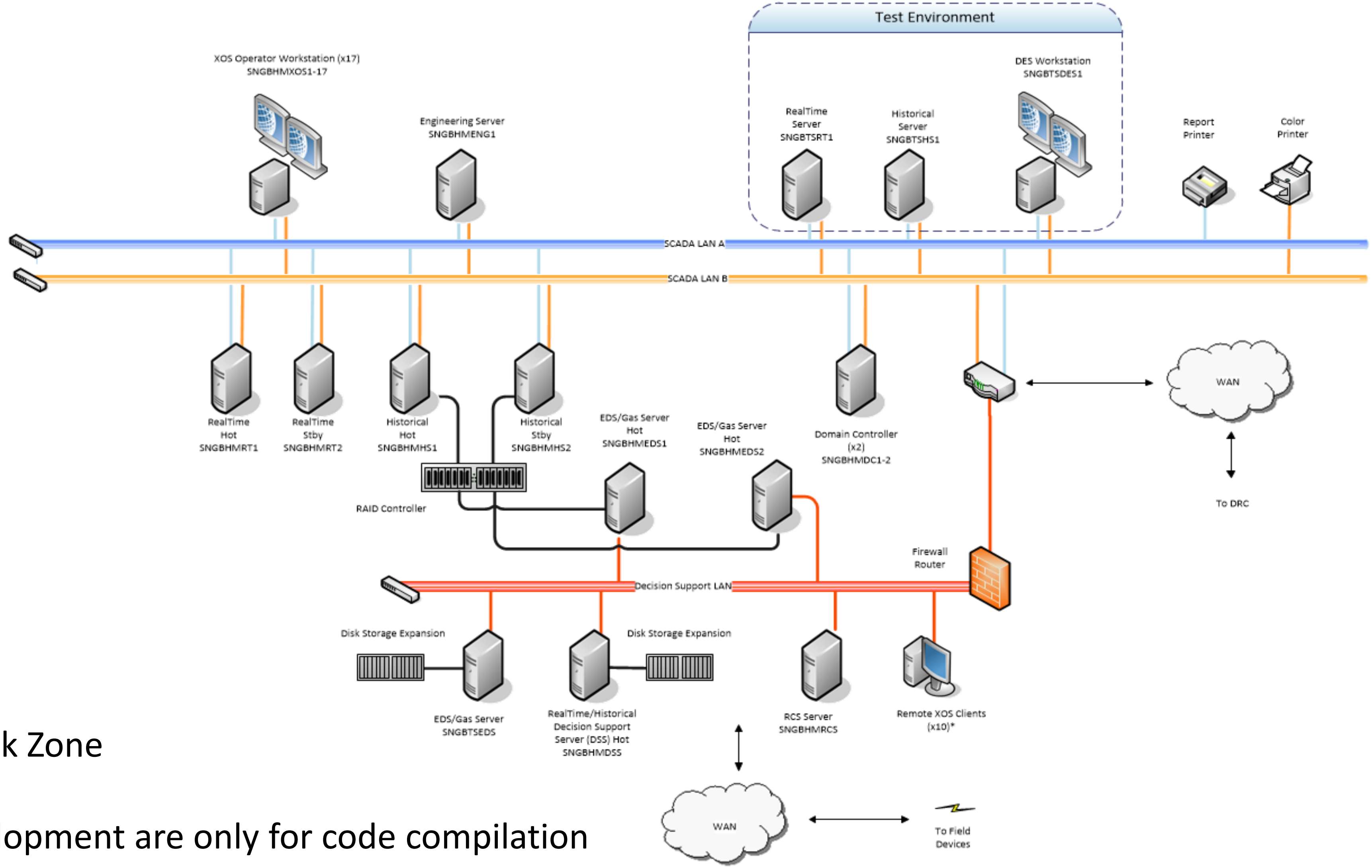
Architecture then



- One Network Zone
- Bare Metal
- Test & Development are only for code compilation

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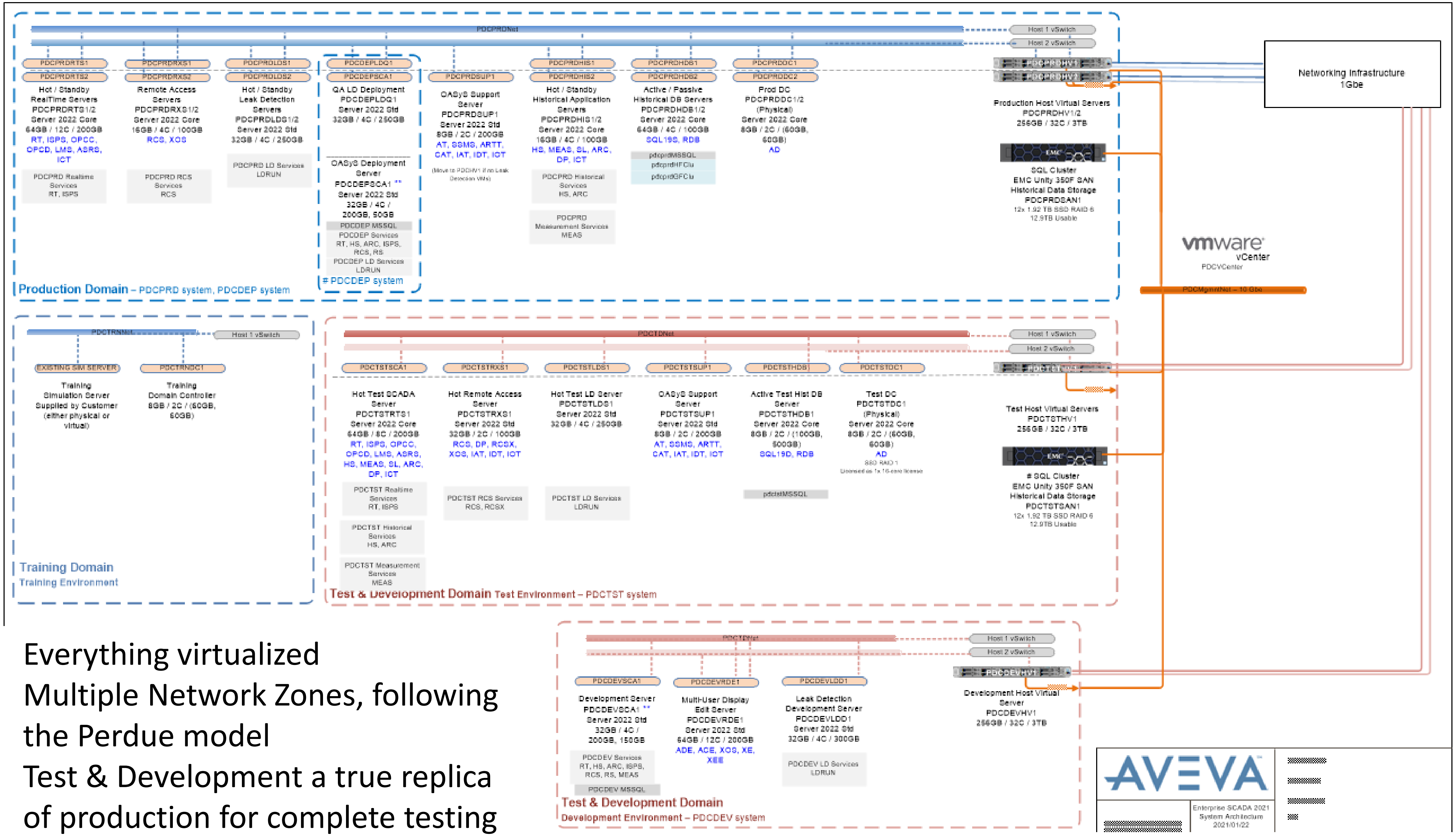
Architecture now



PDCPRDNet

Host 1 vSwitch

Host 2 vSwitch

PDCPRDRTS1
PDCPRDRTS2
Hot / Standby
RealTime Servers
PDCPRDRTS1/2
Server 2022 Core
64GB / 12C / 200GB
RT, ISPS, OPCC,
OPCD, LMS, ASRS,
ICT

PDCPRD Realtime
Services
RT, ISPS

PDCPRDRXS1
PDCPRDRXS2
Remote Access
Servers
PDCPRDRXS1/2
Server 2022 Core
16GB / 4C / 100GB
RCS, XOS

PDCPRD RCS
Services
RCS

PDCPRDLDS1
PDCPRDLDS2
Hot / Standby
Leak Detection
Servers
PDCPRDLDS1/2
Server 2022 Std
32GB / 4C / 250GB

PDCPRD LD Services
LDRUN

PDCDEPLDQ1
PDCDEPSCA1
QA LD Deployment
PDCDEPLDQ1
Server 2022 Std
32GB / 4C / 250GB

OASyS Deployment
Server
PDCDEPSCA1 **
Server 2022 Std
32GB / 4C /
200GB, 50GB

PDCDEP MSSQL

PDCDEP Services
RT, HS, ARC, ISPS,
RCS, RS

PDCDEP LD Services
LDRUN

PDCDEP system

PDCPRDSUP1
OASyS Support
Server
PDCPRDSUP1
Server 2022 Std
8GB / 2C / 200GB
AT, SSMS, ARTT,
CAT, IAT, IDT, IOT

(Move to PDCHV1 if no Leak
Detection VMs)

PDCPRDHIS1
PDCPRDHIS2
Hot / Standby
Historical Application
Servers
PDCPRDHIS1/2
Server 2022 Core
16GB / 4C / 100GB
HS, MEAS, SL, ARC,
DP, ICT

PDCPRD Historical
Services
HS, ARC

PDCPRD
Measurement Services
MEAS

PDCPRDHDB1
PDCPRDHDB2
Active / Passive
Historical DB Servers
PDCPRDHDB1/2
Server 2022 Core
64GB / 4C / 100GB
SQL19S, RDB

pdcprdMSSQL
pdcprdHFClu
pdcprdGFClu

PDCPRDDC1
PDCPRDDC2
Prod DC
PDCPRDDC1/2
(Physical)
Server 2022 Core
8GB / 2C / (60GB,
60GB)
AD

PDCPRDHV1
PDCPRDHV2
Production Host Virtual Servers
PDCPRDHV1/2
256GB / 32C / 3TB

EMC
SQL Cluster
EMC Unity 350F SAN
Historical Data Storage
PDCPRDSAN1
12x 1.92 TB SSD RAID 6
12.9TB Usable

Production Domain – PDCPRD system, PDCDEP system

Networking Infrastructure
1Gbe

vmware
vCenter
PDCVCenter

PDCMgmntNet – 10 Gbe

PDCTRNNet

Host 1 vSwitch

EXISTING SIM SERVER
Training
Simulation Server
Supplied by Customer
(either physical or
virtual)

PDCTRNDC1
Training
Domain Controller
8GB / 2C / (60GB,
60GB)

Training Domain
Training Environment

PDCTDNet

Host 1 vSwitch

Host 2 vSwitch

PDCTSTSCA1
Hot Test SCADA
Server
PDCTSTRTS1
Server 2022 Core
64GB / 8C / 200GB
RT, ISPS, OPCC,
OPCD, LMS, ASRS,
HS, MEAS, SL, ARC,
DP, ICT

PDCTST Realtime
Services
RT, ISPS

PDCTST Historical
Services
HS, ARC

PDCTST Measurement
Services
MEAS

PDCTSTRXS1
Hot Remote Access
Server
PDCTSTRXS1
Server 2022 Std
32GB / 2C / 100GB
RCS, DP, RCSX,
XOS, IAT, IDT, IOT

PDCTST RCS Services
RCS, RCSX

PDCTSTLDS1
Hot Test LD Server
PDCTSTLDS1
Server 2022 Std
32GB / 4C / 250GB

PDCTST LD Services
LDRUN

PDCTSTSUP1
OASyS Support
Server
PDCTSTSUP1
Server 2022 Std
8GB / 2C / 200GB
AT, SSMS, ARTT,
CAT, IAT, IDT, IOT

PDCTSTHDB1
Active Test Hist DB
Server
PDCTSTHDB1
Server 2022 Core
8GB / 2C / (100GB,
500GB)
SQL19D, RDB

pdctstMSSQL

PDCTSTDC1
Test DC
PDCTSTDC1
(Physical)
Server 2022 Core
8GB / 2C / (60GB,
60GB)
AD
SSD RAID 1
Licensed as 1x 16-core license

PDCTSTHV1
Test Host Virtual Servers
PDCTSTHV1
256GB / 32C / 3TB

EMC
SQL Cluster
EMC Unity 350F SAN
Historical Data Storage
PDCTSTSAN1
12x 1.92 TB SSD RAID 6
12.9TB Usable

Test & Development Domain Test Environment – PDCTST system

PDCTDNet

Host 1 vSwitch

Host 2 vSwitch

PDCDEVSCA1
Development Server
PDCDEVSCA1 **
Server 2022 Std
32GB / 4C /
200GB, 150GB

PDCDEV Services
RT, HS, ARC, ISPS,
RCS, RS, MEAS

PDCDEV MSSQL

PDCDEVRDE1
Multi-User Display
Edit Server
PDCDEVRDE1
Server 2022 Std
64GB / 12C / 200GB
ADE, ACE, XOS, XE,
XIII

PDCDEVLDD1
Leak Detection
Development Server
PDCDEVLDD1
Server 2022 Std
32GB / 4C / 300GB

PDCDEV LD Services
LDRUN

PDCDEVHV1
Development Host Virtual
Server
PDCDEVHV1
256GB / 32C / 3TB

Test & Development Domain
Development Environment – PDCDEV system

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Enterprise SCADA 2021
System Architecture
2021/01/22

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

- Everything virtualized
- Multiple Network Zones, following the Perdue model
- Test & Development a true replica of production for complete testing

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Major Differences

Domains

- Each zone (DSS, test, prod, development) has its own domain

Virtualization

- Domain Controllers are still physical
- VMware or Hyper-V

Management of Change

- Deployment server in production
- Test servers and development servers

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Security

Developing the secure mind-set

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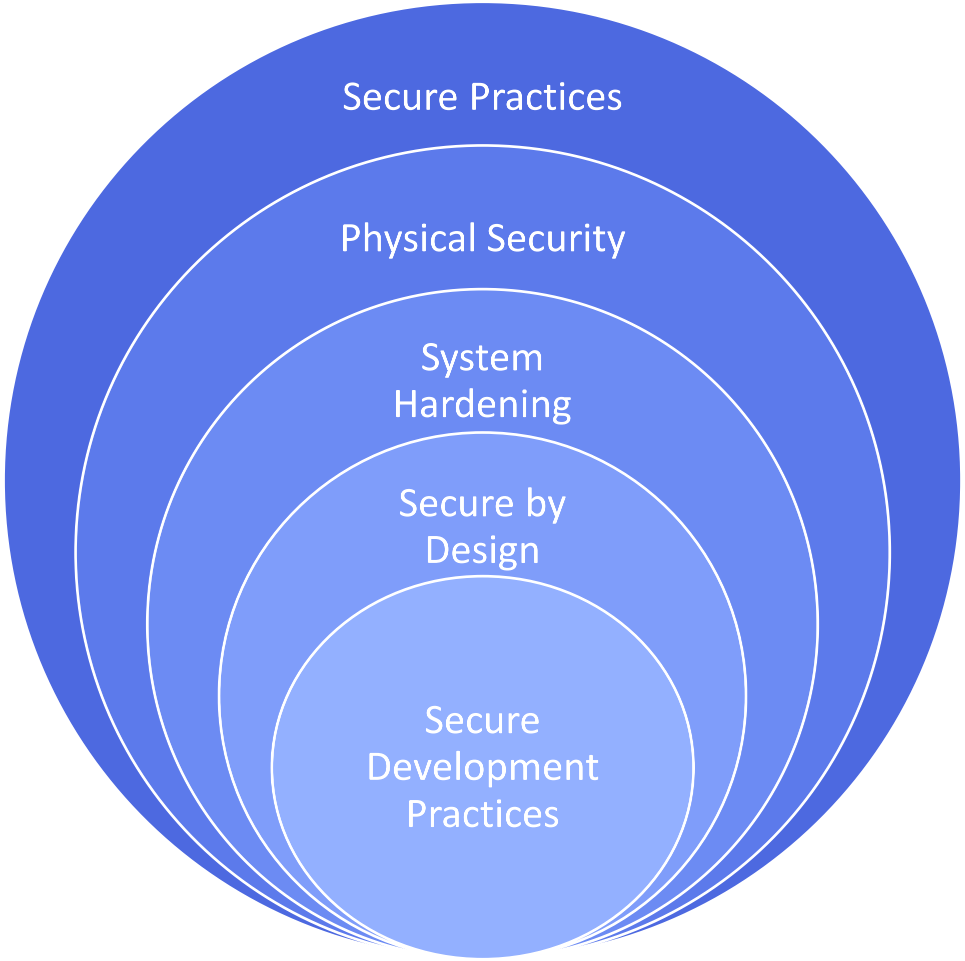
Security in Depth



Secure Practices

- Constant monitoring of the system for Intrusion Detection
- Business continuity plans in the event of an attack
- Employee security training
- Many third-party audits

No system is secure forever!

Physical Security

- Building access restrictions: Control Room, Server Room etc.
- Remote access via VPN and VDI

Some standards require camera monitoring

Deployed System Design

- Secure networking that follows the Purdue model
- Group Policy (GPOs) - lock down over 1200 settings
- Disable non-needed services and default accounts
- Firewall deny by default. System designed to reduce open ports

Deployed solution includes more than just our product

Product is Secured by Design

- Security is the first thought, not an after thought
- Leverage Active Directory
- Kerberos authentication for SSO
- User authority asserted from end to end

Active Directory enables 2-Factor Auth, centralized management

Security Development Lifecycle (SDL)

- AVEVA ISASecure® SDLA Certified Process
- Aligned with IEC 62443 standard
- Integrated into our Agile/Lean development practices
- Dedicated Security Advisors

Prevent exploits before they happen

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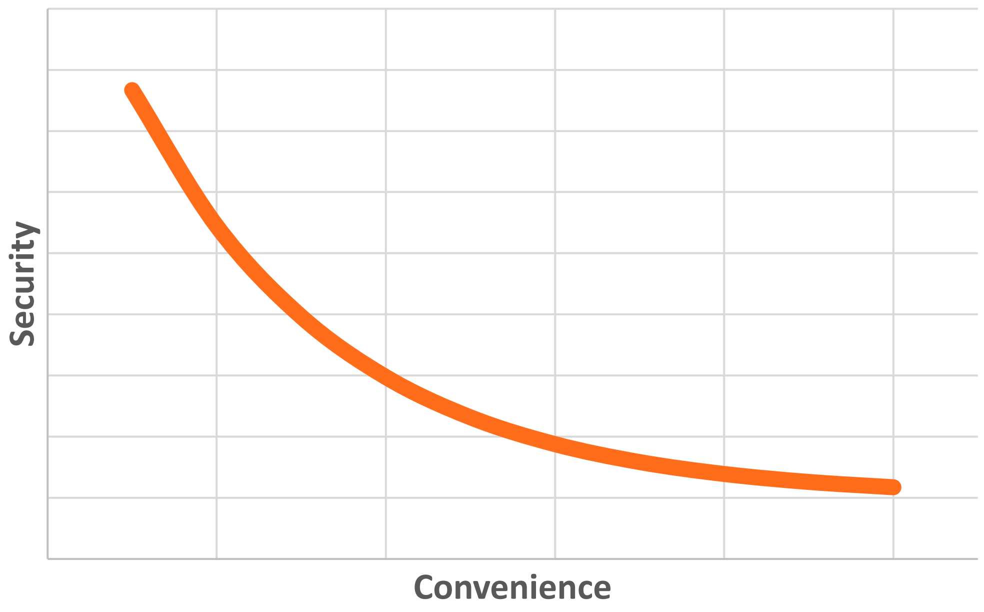
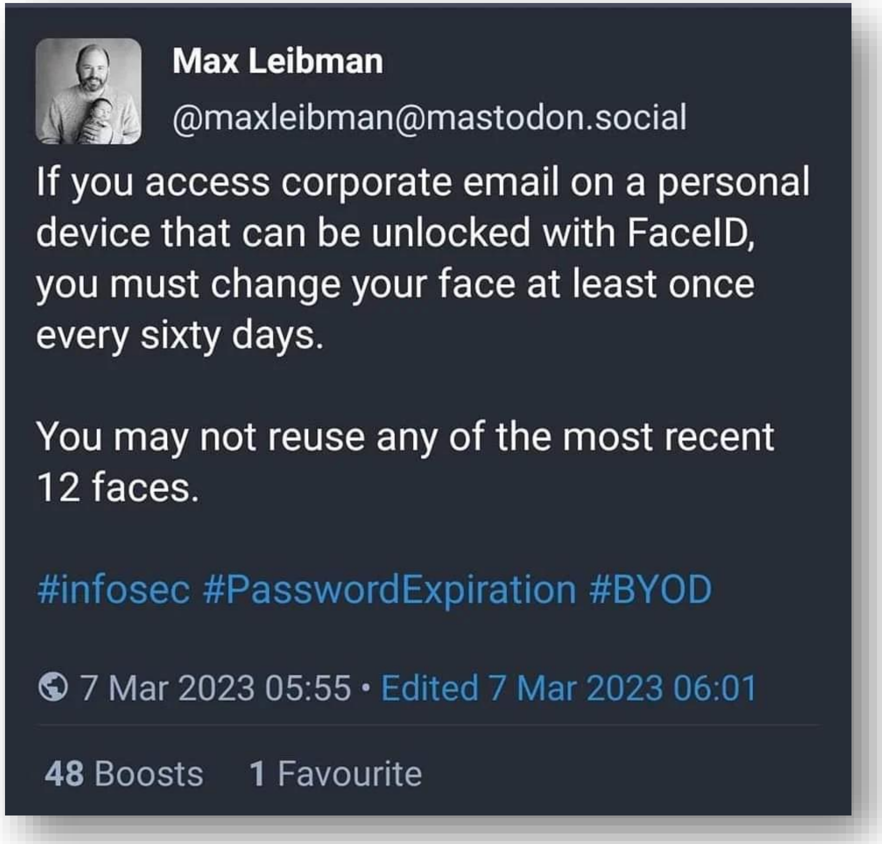
Security versus Convenience

Find the right balance, or your users will do it for you





Max Leibman
@maxleibman@mastodon.social

If you access corporate email on a personal device that can be unlocked with FaceID, you must change your face at least once every sixty days.

You may not reuse any of the most recent 12 faces.

#infosec #PasswordExpiration #BYOD

7 Mar 2023 05:55 • Edited 7 Mar 2023 06:01

48 Boosts **1** Favourite

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HMI

The ASM revolution

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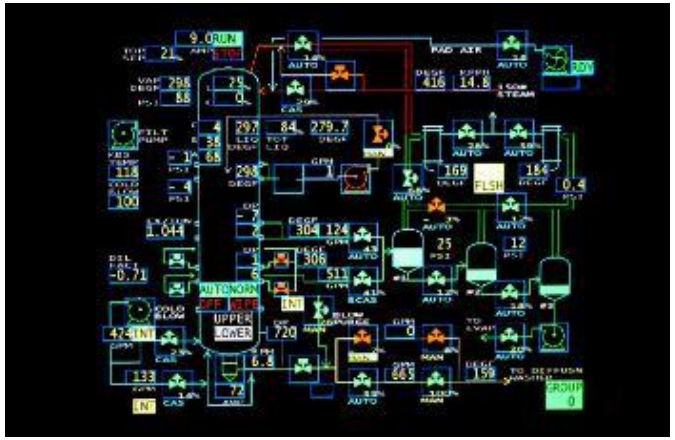
SCADA: HMI

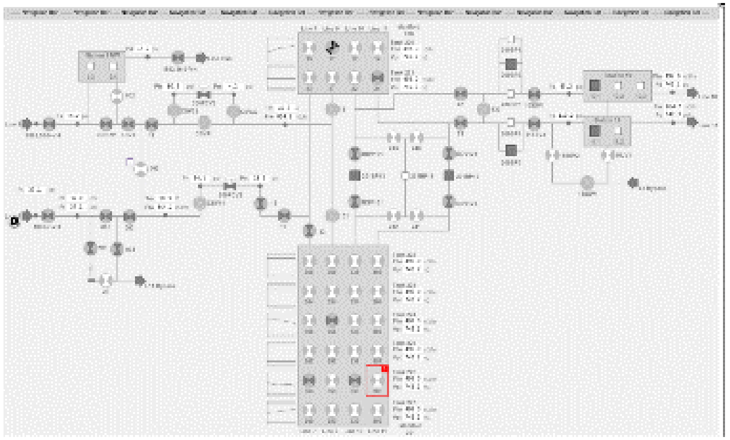
Increasing information density

- Control room is skewing younger
- Off the street more common than from the field
- Younger folks trust the computer and expect more from it
- Maintaining accurate schematics is expensive
- Template and object driven display creation reduces ongoing cost.

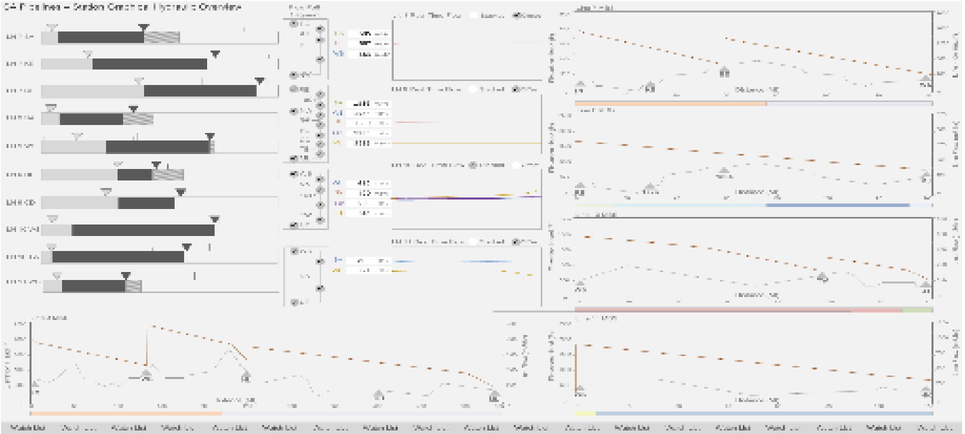
Level 1: schematics



Level 3: station overview



API 1165 Abnormal Situation Monitoring



Going from high cost, high density to lower cost, lower density, to true ASM style displays

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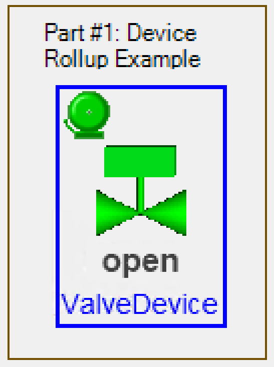
HMI: Abnormal Situation Monitoring (ASM)

Increase information density and reduce clutter

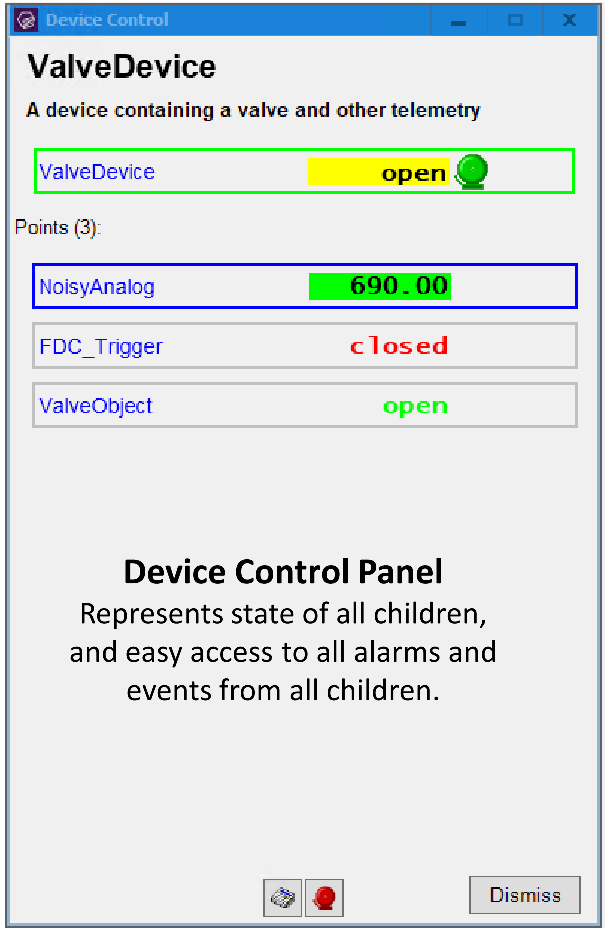

Part #1: Device Rollup Example

open

ValveDevice

Flexible Device Object

Represents current state of the master point, and any other abnormality from the other child point.



ValveDevice

A device containing a valve and other telemetry

ValveDevice	open

Points (3):

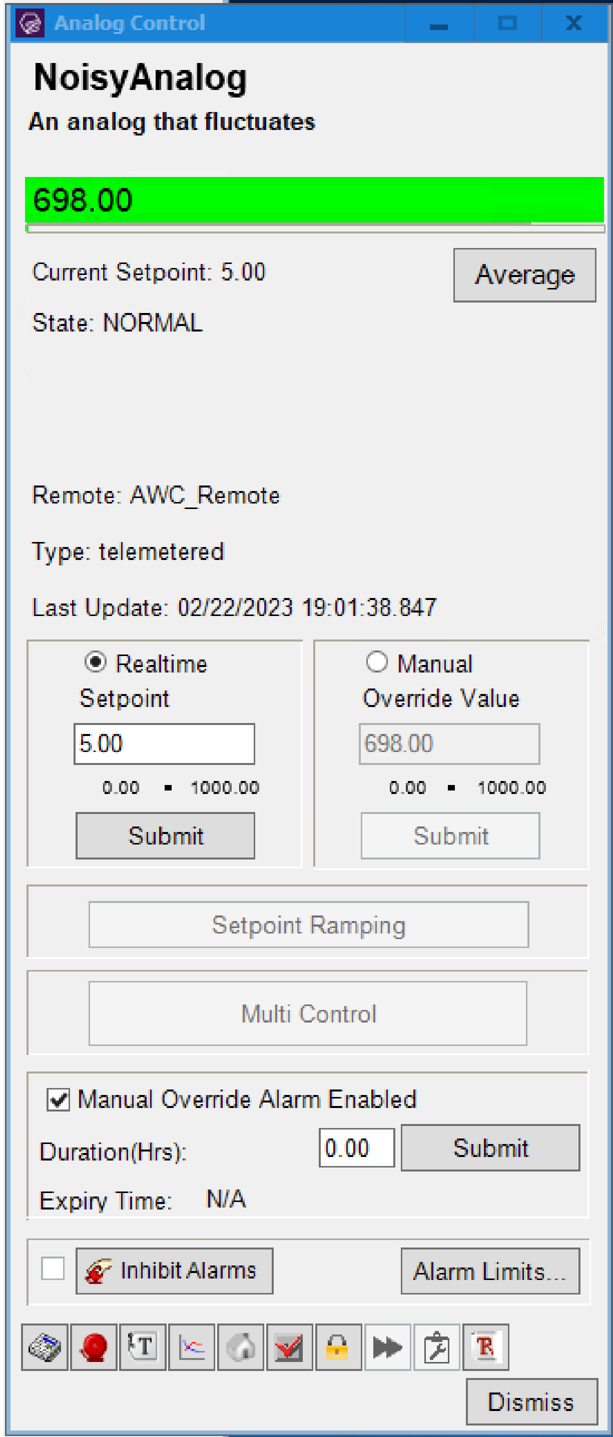
NoisyAnalog	690.00
FDC_Trigger	closed
ValveObject	open

Device Control Panel

Represents state of all children, and easy access to all alarms and events from all children.

Analog Control Panel

Represents the current state of an analog point. This is the lowest level of information available to the operator.



NoisyAnalog

An analog that fluctuates

698.00

Current Setpoint: 5.00

State: NORMAL

Remote: AWC_Remote

Type: telemetered

Last Update: 02/22/2023 19:01:38.847

● Realtime Setpoint: 5.00 (0.00 - 1000.00)

○ Manual Override Value: 698.00 (0.00 - 1000.00)

☑ Manual Override Alarm Enabled

Duration(Hrs): 0.00

Expiry Time: N/A

☐

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SCADA Software

More than just telemetry

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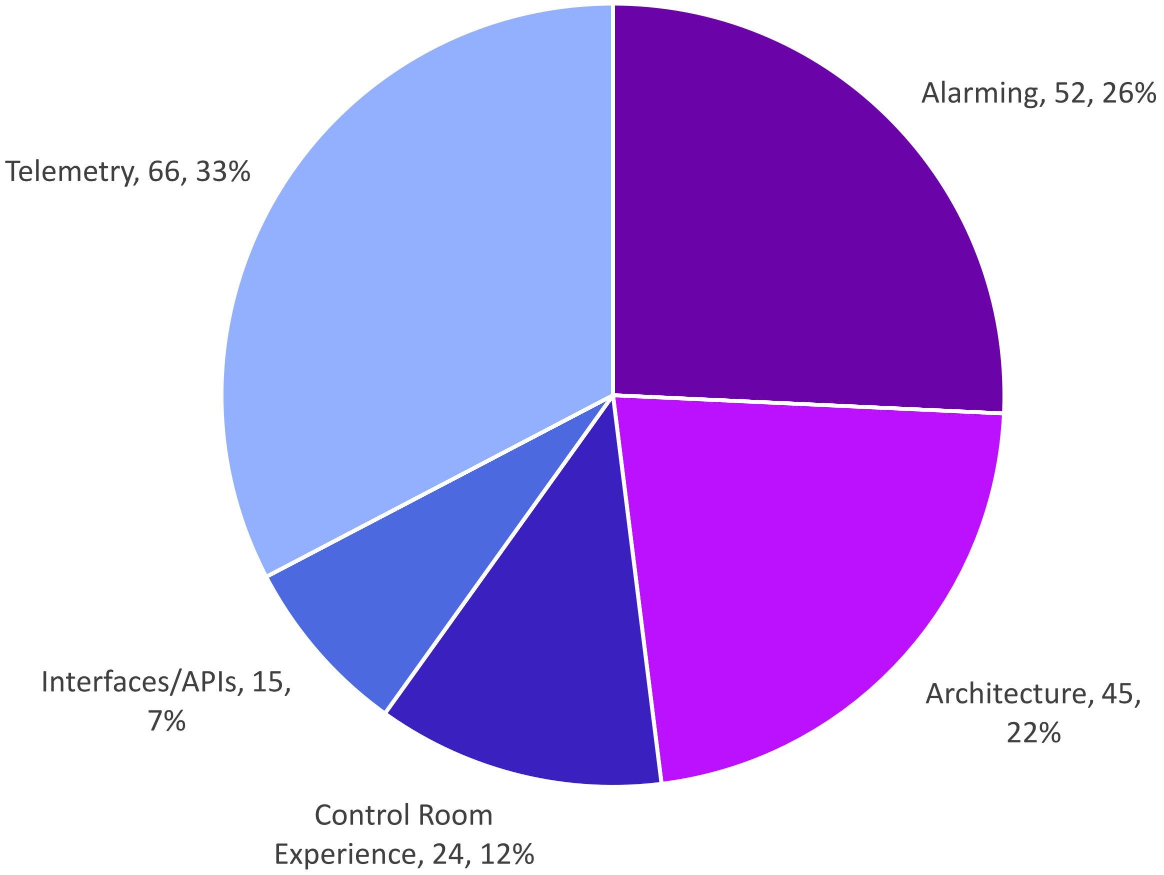
New Enterprise SCADA Features

Over 200 new features that have quickly become the new standard

- Large emphasis on alarm handling and control room experience
  - Support for new HMI objects
  - Productization of many years of project custom code to a single baseline
- Subtle architecture changes to enable big features
  - Live upgradability and binary release
  - Continuous security improvements
- Platform focused
  - New and improved interfaces
  - Creation of new developer documentation



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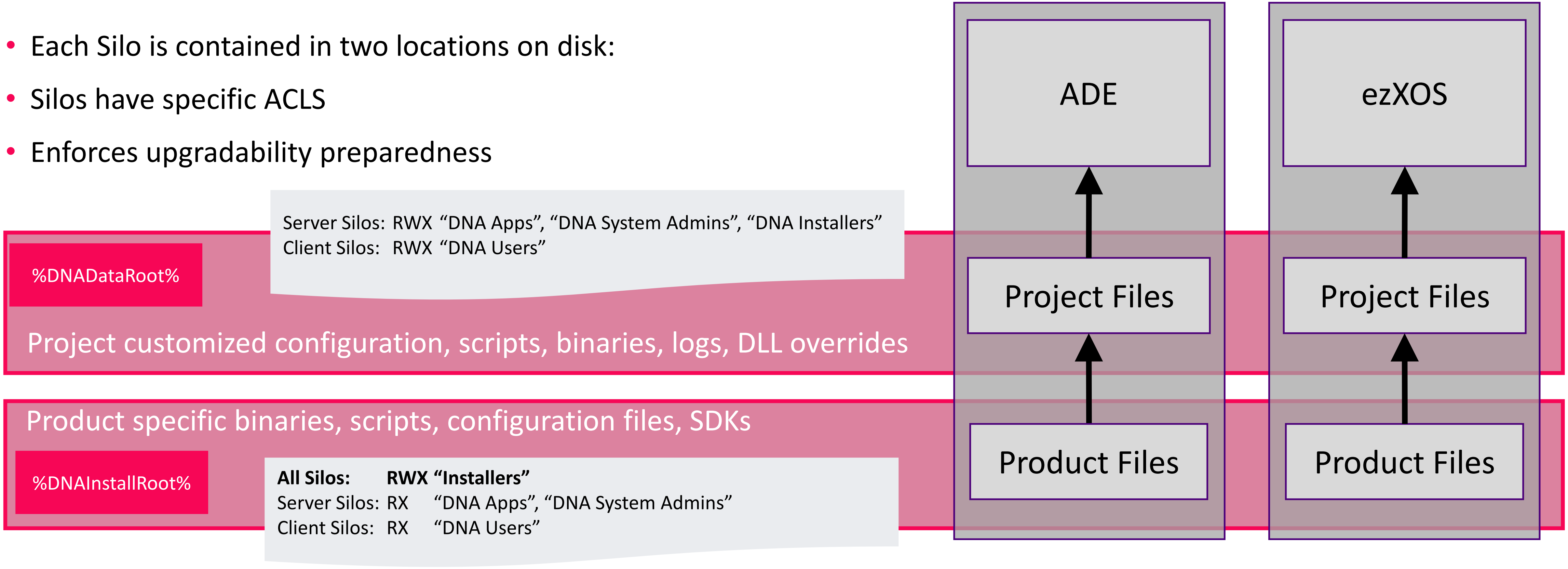
Separating Project Configuration and Extensions from Product

Upgradability, Preserving Project Customizations

- Each Silo is contained in two locations on disk:
- Silos have specific ACLS
- Enforces upgradability preparedness



Server Silos: RWX “DNA Apps”, “DNA System Admins”, “DNA Installers”
Client Silos: RWX “DNA Users”

%DNADataRoot%

Project customized configuration, scripts, binaries, logs, DLL overrides

Product specific binaries, scripts, configuration files, SDKs

%DNAInstallRoot%

All Silos: RWX “Installers”
Server Silos: RX “DNA Apps”, “DNA System Admins”
Client Silos: RX “DNA Users”

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Control Room Management Enhancements

Alarm Handling

- Alarm Parking
- Alerts and Alert Paging
- Alarm Summary Filtering Enhancements
  - Page ack ignore safety/critical
- Alarm Audit Tables

Alarm Suppression

- Remote Alarm Holdoff
- Remote and Connection Alarm Hiding
- Parent/Child, State & Command
- Timed Single and Group

Alarm Configuration

- Alternate Alarm Limits & Bracketing
- Alarm Message Format
- State Specific Safety Alarms
- Measurement Alarm Override
- Absolute Alarming
- High/Low Cutoff
- On / Off Alarm Delay
- Poll Time Exceeded
- Timed Alarm Inhibit
- Separate High / Low Alarms
- Setpoint Creep Alarms
- Tag Expiry
- State Specific Alarm Inhibits

Operator Functionality

- User Unit Conversion
- Operator Notes
- Operator Reminders & One-shot alarms
- Point to Point Verification
- Compressor Performance Monitoring
- Setpoint Ramping
- Manual Override Time Expired

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Data Acquisition and Processing Enhancements

Operation

- Control Interlock
- Deviation Limits Reset on setpoint
- Remote Offscan Preservation
- RTU Test Mode

Processing

- Deadband Performance Optimizations
- Enhance Rate of Change
- Sub-Remote Status Indicator, incl. RBE
- Telemetry Last Change Time
- Jitter Smoothing
- Raw Data Storage

Functionality

- Telemetered Strings with historization
- Pass-Through Interface
- SWANA Translator Plugins
- Station & Device Rollups
- Station Demand Polling
- Alarm Limit Upload and Download
- Data Payload Processor (DPP) & Configural Gas Load (CGL) (select protocols)
- Socket Server Relay Service
- Field Device Trend History
- TCP Listener
- Download by List (select protocols)
- Flatline Watchdog & Device Heartbeats
- Single and Multiple output register bitmasks

Protocols

- AB CIP
- AB DF1
- DNP3
- GE
- PCCC
- SNMP
- BSAP-CGL
- Fisher ROC/ROC+ & CGL
- Mercury
- Totalflow
- XML Protocol
- Xmodbus
- APSI (via MQTT)
- SuperFlo

Configuration

- Configurable Point and Station Types
- Point History after Rename
- Status and Multistate I/O Configuration
- Status Output Message Set
- Asset ID field

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Telemetry

Re-thinking SCADA in the IIoT world

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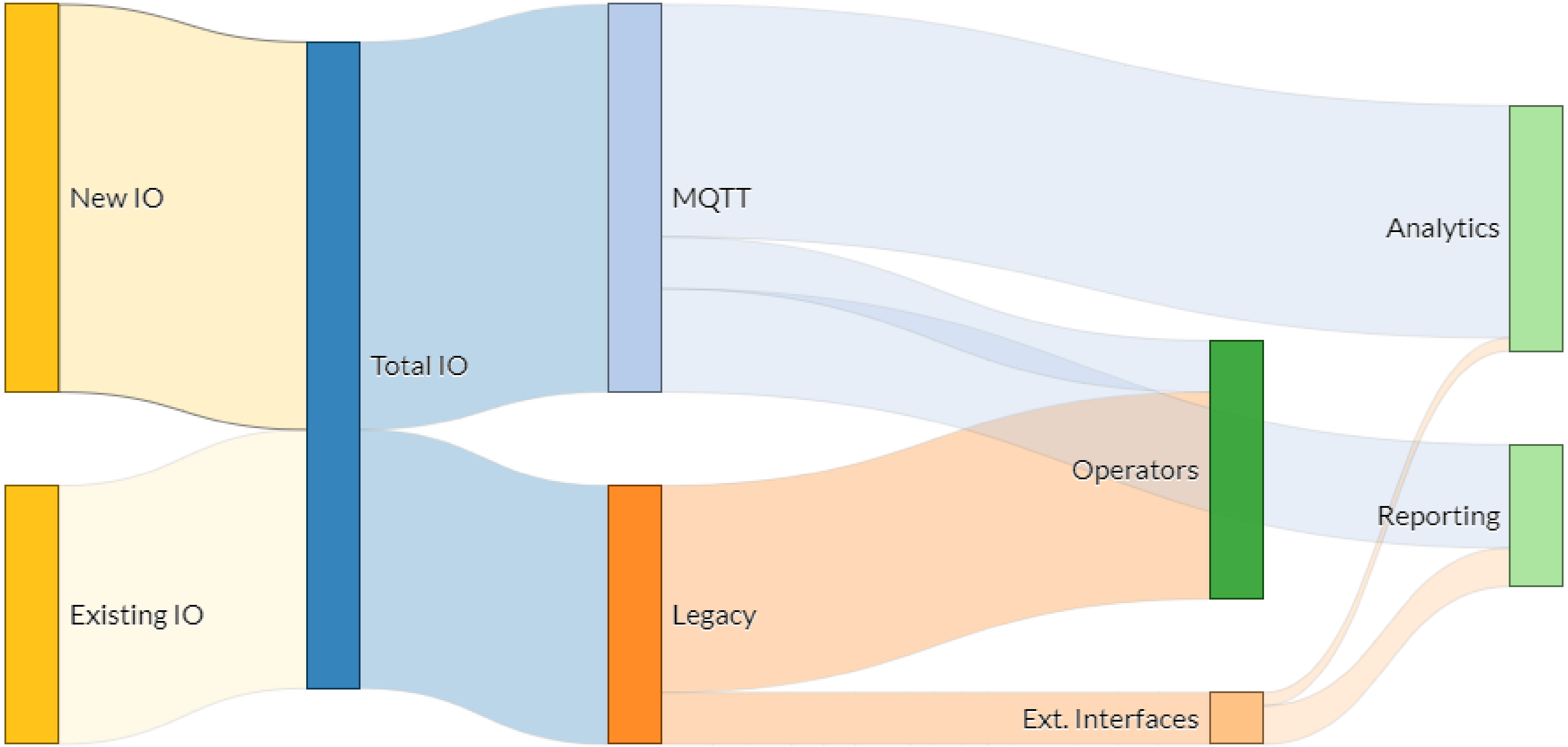
The Future of Telemetry

Getting SCADA out of the middleware business

- When the telemetry pipe was small, we had to be selective on how much to bring back via SCADA
- Focused on what the operator needed
- Things like TCP/IP and MQTT make it possible to bring back 100% of these stranded data islands
- But, no need to bring that all through SCADA.



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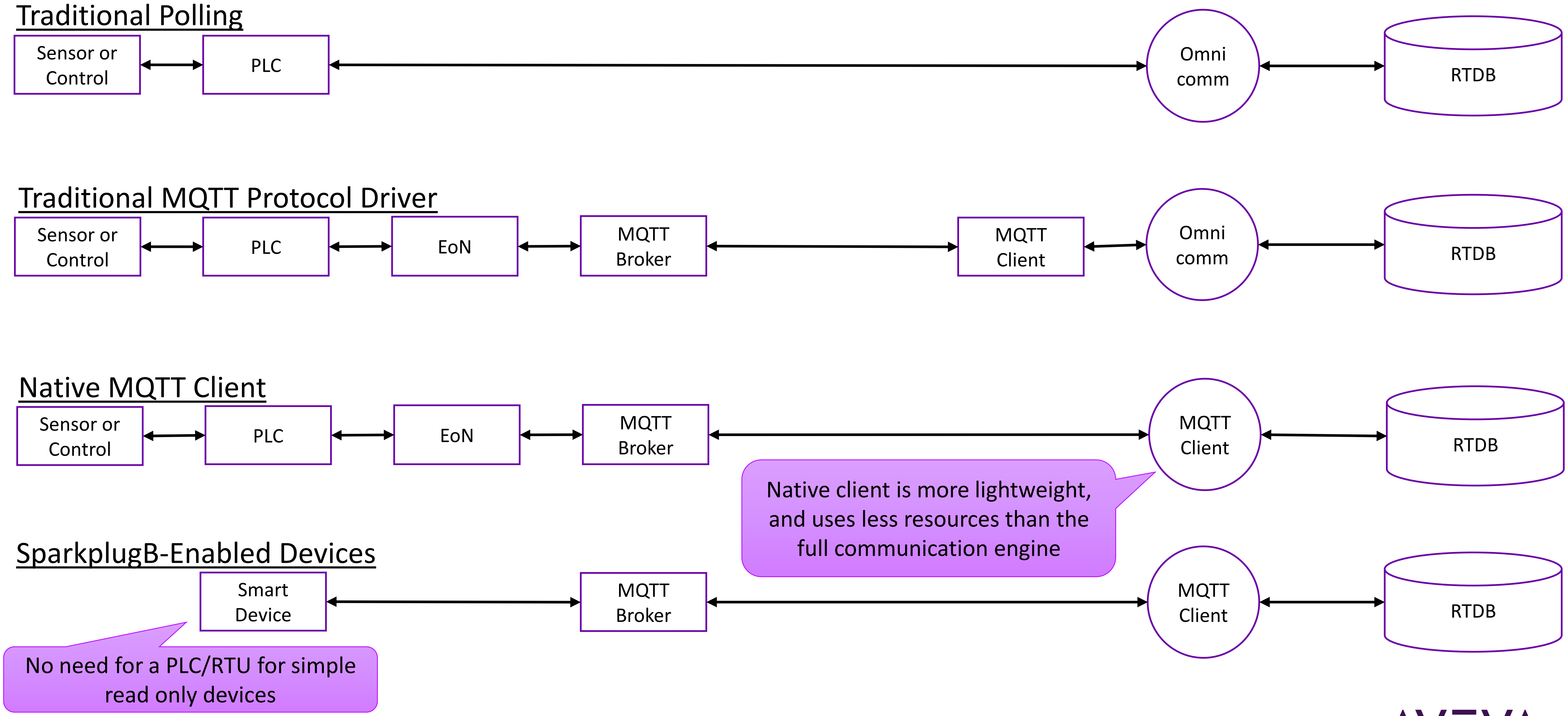
Communication Model Evolution



Native client is more lightweight, and uses less resources than the full communication engine

No need for a PLC/RTU for simple read only devices

EoN = MQTT Edge of Network Node
RTDB = Realtime Database

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SCADA in the Cloud, and the Future of the DSS

What it means in today’s technology and security landscape

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“SCADA in the Cloud”

<table>
<tr><th>Phase</th><th>1. On Prem</th><th>2. PaaS - Customer Colo</th><th>3. IaaS - Vendor Colo</th><th>4. SCADA as a Service *</th><th>5. Cloud Native</th></tr>
<tr><td><b>Infra-structure</b></td><td>Building, power, AC, network provided and maintained by customer or outsourced</td><td colspan="3">Building, power, AC, datacenter network provided and maintained by Colo</td><td>Native cloud point of presence in multiple countries/regions</td></tr>
<tr><td><b>Field Comms</b></td><td>On-prem equipment(modems, leased lines, etc.) provided and maintained by customer</td><td>Less on-prem equipment required. VPNs into Colo.</td><td>Little to no on-prem equipment required. VPNs into Colo.</td><td>Very little equipment on-prem, if any. VPNs to site. Edge to Enterprise.</td><td>Field comms through Edge to Enterprise solutions</td></tr>
<tr><td><b>Hardware</b></td><td colspan="2">Bare-metal or VM.
HW provided and maintained by customer</td><td>100% VM based.
HW provided and maintained by Colo</td><td>100% VM based.
Some features SOA-based</td><td>100 % SOA-based</td></tr>
<tr><td><b>Host OS maint.</b></td><td colspan="2" rowspan="2">Customer OT or IT</td><td>Vendor</td><td rowspan="3">Reseller DevOps</td><td rowspan="3">Vendor DevOps</td></tr>
<tr><td><b>Gust OS maint.</b></td><td rowspan="2">Customer OT admin team, or SCADA Vendor</td></tr>
<tr><td><b>SCADA app maint.</b></td><td colspan="2">Customer OT admin team, or SCADA Vendor</td></tr>
<tr><td><b>SCADA admin</b></td><td colspan="4">Customer OT</td><td>Vendor DevOps</td></tr>
<tr><td><b>Operator Workstation</b></td><td colspan="2">Thick Client &amp; RCS</td><td colspan="3">Thick Client, RCS, Web Native</td></tr>
</table>

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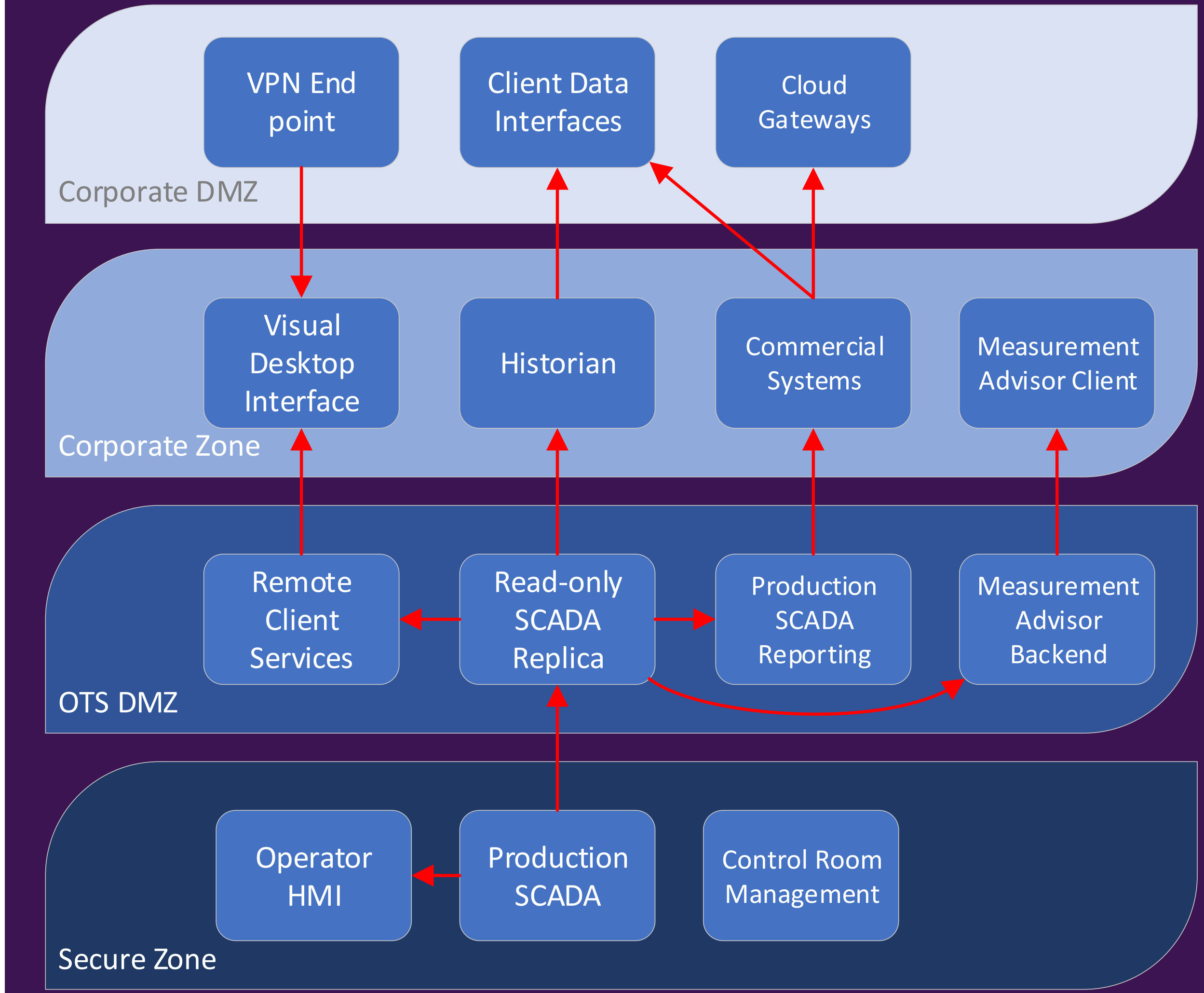
* Note that some integrators are already offering SCADA as a Service

What is a Decision Support System?

Often used interchangeably with DMZ

- What is the DMZ?
  - An important network buffer zone that separates the production zone from less secure zones
  - Hosts systems that are needed by the less-secure side, but depends on data from the more-secure side
  - Connections to send data into a DMZ must be initiated by the more secure side (Purdue Model)
- What goes in a DSS and who uses it?
  - Its traditional purpose was to provide a system that non-control-room users can use without risk of impacting the production control system
  - Implemented as a read-only replica of the Production System
  - It was thought that domain trusts would be used to grant access to non-control-room users, without adding additional maintenance load to the OT administrators



Traditional on-prem DSS

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Future of Decision Support System

The DSS becomes a dedicated OT DSS

- Zero Trust Architecture
  - Cross-domain trusts are not almost never used
  - Corporate users looking for OT data streams are rarely given access to the OT DSS, and even if they are, struggle to find and extract what they want.
- Historian
  - Moved out of the OT DMZ into the corporate zone long ago, with the next evolution being cloud-based historians like AVEVA DataHub® based on PI
- Reporting
  - Ad-hoc Operational Conditions do not need replicas of the SCADA operator screens.
  - Transition from SQL Reporting to AVEVA Reports®, AVEVA Insight®, reducing the burden on OT staff creating new reports by enabling self-serve
- Remote Operator HMI
  - Control Room Supervision via the OT DSS. Refine security model to give fine grain of controllability

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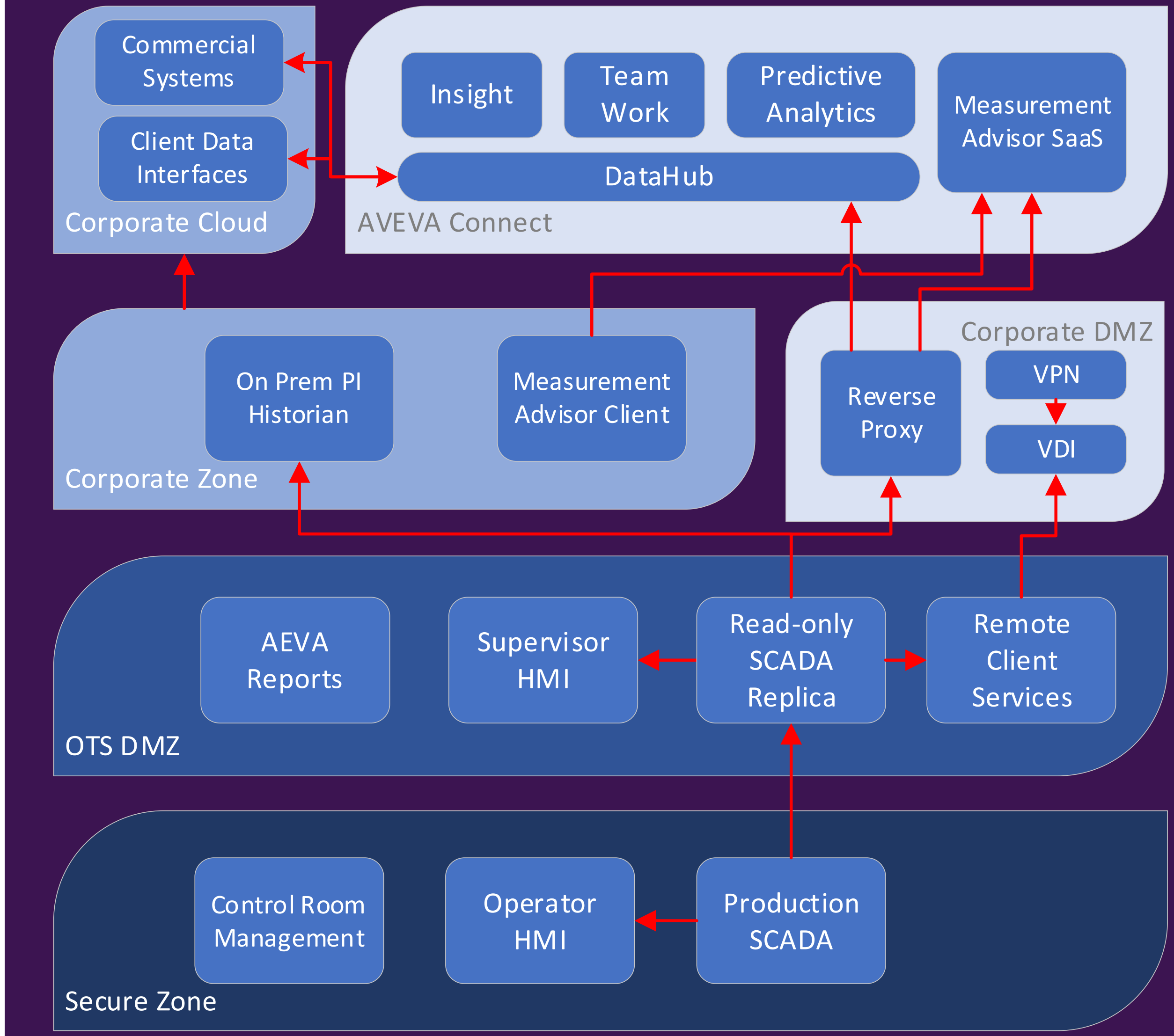

Cloud Hybrid DSS

KGA - MARCH 14, 2023

Beyond SCADA

Keeping the boardroom happy

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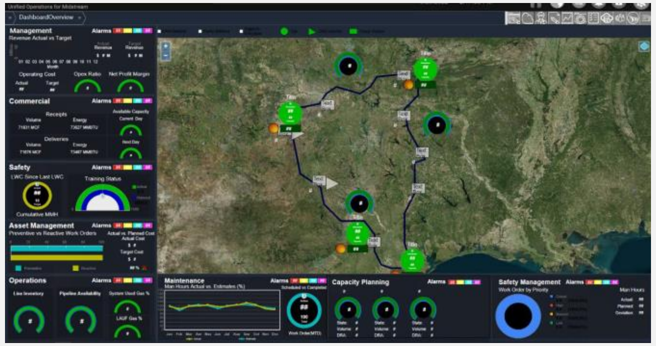
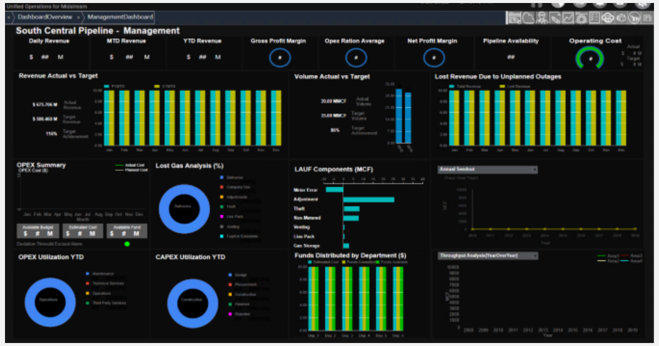
Empowering People Across the Organization

Enterprise visualization

- High-level perspective
- Consolidated content
- Enriched data in context
- Connected workforce enablement
- Operating environment for decisions





Maintenance

AI/ML

Engineering Information

3D Models

Financial & Business

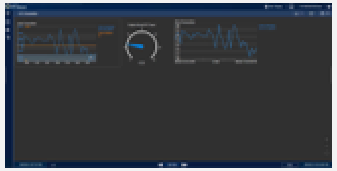
Weather

Other Data Systems

Wider information in context to operations

Operations Control

Data Management



Instrumented Assets

Non-Instrumented Assets

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ABOUT AVEVA

AVEVA is a global leader in industrial software, driving digital transformation and sustainability. By connecting the power of information and artificial intelligence with human insight, AVEVA enables teams to use their data to unlock new value. We call this Performance Intelligence. AVEVA's comprehensive portfolio enables more than 20,000 industrial enterprises to engineer smarter, operate better and drive sustainable efficiency. AVEVA supports customers through a trusted ecosystem that includes 5,500 partners and 5,700 certified developers around the world. The company is headquartered in Cambridge, UK, with over 6,500 employees and 90 offices in over 40 countries.

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