TECHNOLOGY EVALUATIONS FOR TEST TEAM REMOTE PRESENCE AT NASA LANGLEY RESEARCH CENTER

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Presentation Outline

- Objective
- Cultural Differences
- Facility Survey
- Investigated Technologies
- Potential Application
- Issues
- Future Steps

Objective

- The objective of the remote presence project is to assess existing technologies that may allow us to provide routine participation in research activities from geographically remote locations
- The scope began as very broad and, as the investigation progressed, narrowed to:
  - From a Ground Test Facility perspective
    - Both aeronautical AND structural test facilities
  - Accessing data remotely to aid in guiding the direction of the test
    - NOT getting data to a remote computer for reduction

Data Types

Data
- Structural testing data
- Aeronautical testing data
  - Cyclic/Trending data
  - Preliminary point data

Video
- Video feed
- Sharing Desktop or Applications

Audio
- Voice over IP
- Telephone

Facility Types

Closed-Circuit Wind Tunnels
- National Transonic Facility
- 14x22
- Transonic Dynamics Tunnel
- 0.3 m Transonic Cryogenic Tunnel

Blow-down Wind Tunnels
- 8' High Temperature Tunnel
- Supersonic Combustion Ramjet Test Complex
- Langley Aerothermodynamics Laboratory
- Supersonic Wind Tunnel
- Low Speed Aeroacoustics Wind Tunnel

Structural Test Facilities
- Combined Loads Test System
- Landing and Impact Research Facility

Data Acquisition Systems:
Blue = TestSLATE
Yellow = OADAS
Green = Pacific Instruments
Purple = Custom Software

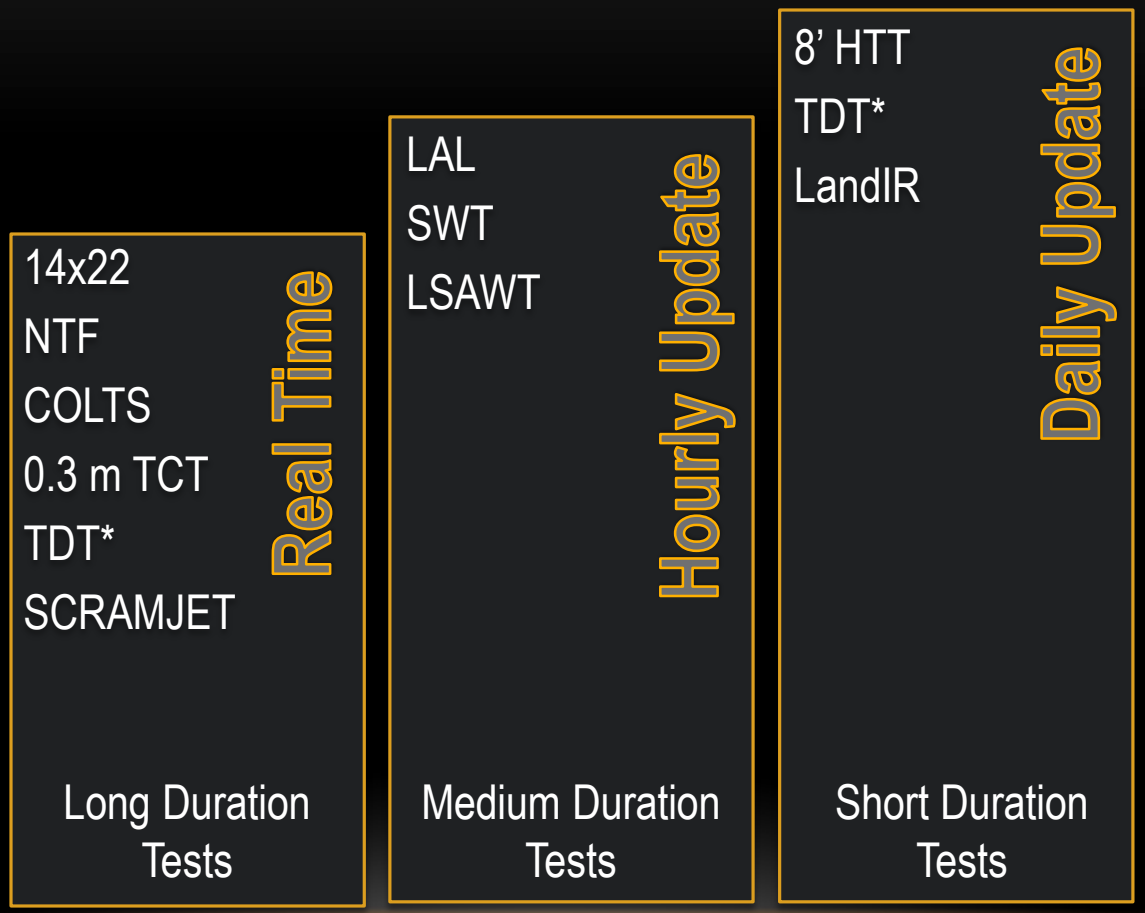
Cultural Differences

- Security
  - Sensitive Data (Proprietary/SBU)
    - Customers (Proprietary) require secure transfers
    - Federal Government (SBU) requires specific secure transfers
  - Non-Sensitive Data
    - Not too concerned about confidentiality
- Availability of data to the customer
  - There are differences in 'what data gets to the customers at what point in time' across facilities
  - We are investigating 'technical possibilities.' When to implement them is out of scope of our effort
- People found it hard to think outside of the way they do things.
  - No well formed requirements for this type of capability
  - Will take experience through cyclical development cycle to better define what capabilities to pursue

Facility Survey

- Closed-Circuit Wind Tunnels
  - Continuous wind flow with hours of testing
  - Usually perform multiple runs per day
  - Engineers in control room are in charge of the operations
    - Can decide to skip certain batches/runs based on test data
- Blow-down Wind Tunnels
  - Short duration tests of less than 5 minutes. Vacuum driven airflow.
  - Testing frequency much more varied than closed-circuit wind tunnels. Some do only one run per day, some do a couple runs per day.
- Structural Test Facilities
  - Force loading and measurements
  - Typically long duration test runs

Most Beneficial Data Feedback Frequency



Specific Technologies Investigated

Technologies

Data

- DataTurbine
- Matlab OPC Toolbox
- aeroCOMPASS

Audio/Video

- VLC
- FFMPEG
- RTSP stream from video server
- Matlab
- WebEx
- Vidyo
- Tricaster
- Remote Desktop
- Hauppauge WinTV7 Extend

Customer Clients

- UWAL Plot
- WinPlot
- rbnbPlot
- RDV
- Matlab
- LabVIEW Web UI
- Custom Client

Specific Data Technologies Investigated

- DataTurbine
  - Java-based data transport tool for streaming heterogeneous data in real time
  - Three major components
    - Data acquisition devices (sources)
    - A Ring Buffered Network Bus (RBNB) server—think of this as “the cloud”
    - Data utilization applications (sinks)
  - Users typically use and manipulate their preferred clients
- Matlab OPC Toolbox
  - TestSLATE provides data to an OPC server that Matlab can retrieve
  - Matlab allows remote data access to OPC server via TCP/IP connection
  - Matlab integrates with DataTurbine nicely due to Java basis
- aeroCOMPASS
  - A commercial web-based collaborative document and data sharing site
    - An Alfresco system (similar to SharePoint)

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Specific Video Technologies Investigated

- VLC
  - Free, open source cross-platform multimedia player
  - Works with various streaming protocols to stream audio and video
  - Can be used independently or with DataTurbine for “TiVo” capability
- FFMPEG
  - Free cross-platform application to record, convert, and stream audio and video
  - Can be used independently or with DataTurbine for “TiVo” capability
- Matlab
  - Standard license has capability of manipulating prerecorded videos
  - Additional Toolboxes available to acquire and process images/video from hardware
  - Potential for sending video streams through DataTurbine as well as data
    - This capability has yet to be investigated/evaluated

Specific Video Technologies Investigated

- WebEx
  - Current agency offering for teleconferencing
  - Allows sharing of desktop, applications, web browsers, etc. by one person at a time
  - Has whiteboard capability for annotation of shared objects
  - Requires secure NASA login for SBU information
    - Can invite non-NASA personnel to join conference
  - Requires a telephone in order to get audio
  - Non-presenting participants have no direct control over what they see
  - Secure, encrypted connection using SSL from anywhere
    - Runs on 3G, 4G, Wi-Fi, etc.
    - Can join conferences from mobile devices

Specific Video Technologies Investigated

- Vidyo
  - New agency offering for teleconferencing
  - Allows sharing of desktop, applications, web browsers, etc. by each person
    - Each person can only share one thing
    - User chooses which 'one thing' they want to see but can't manipulate it at this time
  - Currently no whiteboard ability—Expected later this year
  - Requires secure NASA login for SBU information
    - Can invite non-NASA personnel to join conference
  - Uses Voice over IP, similar to Skype—No telephone required for audio
  - Secure, encrypted connection using SSL from anywhere
    - Runs on 3G, 4G, Wi-Fi, etc.
    - Can join conferences from mobile devices, but currently requires an account

Specific Video Technologies Investigated

- Tricaster
  - Portable HD Video Studio that can stream audio and video to the network
  - Able to stream from one of 3 connected cameras or the display of a remote computer
  - Remote users don't have the ability to control what they see
- Remote Desktop
  - Remotely log into computer and use it as if you were there
  - Requires a dedicated workstation in the control room
  - Remote users need NAMS account request for credentials for VPN access
  - Would require a conference room for more than one remote customer to view
  - Wouldn't be able to connect to a computer in control room from offsite
- Hauppauge WinTV7 Extend
  - Ability to stream from video capture card to web server on local network

Specific Technologies Investigated

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Customer Clients

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- Matlab
- LabVIEW Web UI
- Custom Client

Specific Client Platforms Investigated

- University of Washington Aeronautical Laboratory Plot (UWAL Plot)
  - Specifically mentioned as a preferred client by Boeing
  - Facilities that have a free license file can use the plotting software—as can their customers
  - Capable of real time data plotting
    - Will read an updated file when instructed to by a web server
- WinPlot
  - Developed at Marshall Space Flight Center
  - Used extensively at Marshall for propulsion analysis on SSME's, Delta Program, etc.
  - Capable of real time data plotting
    - Can import ASCII text files

Specific Client Platforms Investigated

- rbnbPlot
  - Free plotting package included with DataTurbine
  - Can display data as tables or plots
    - Plots cannot be overlaid for comparison
  - Can display images and video in same window as tabular/graphical data
    - Can't handle audio or any form of encapsulation
- Real Time Data Viewer (RDV)
  - Free Java interface for viewing and analyzing data locally or from DataTurbine server
  - Capable of displaying textual and numerical data, still images, and video
    - Can't handle audio or any form of encapsulation
    - Plots can be overlaid for comparison
  - Playback rate can be adjusted so data is presented slower or faster than real time to aid in analysis

Specific Client Platforms Investigated

- Matlab
  - Can serve as a sink to plot and analyze data from DataTurbine server
  - Analyzed data can be placed back on DataTurbine server
  - Would require familiarity with DataTurbine to do effectively
- LabVIEW WebUI
  - Based on Microsoft Silverlight
  - Can develop web-based thin client applications to allow users to remotely monitor data through a secure web browser
  - Being phased out in coming years due to Microsoft's lack of Silverlight development
- Custom Client
  - A custom sink could be developed to operate however we want and distributed to customers
  - Would require time, money, and familiarity with DataTurbine and programming languages

Free

Data

- DataTurbine (DT)
- aeroCOMPASS

Audio/Video

- VLC + DT
- FFMPEG + DT
- Remote Desktop
- WinTV7 Extend

Customer Clients

- UWAL Plot
- WinPlot
- rbnbPlot
- RDV

Not Free

Data

- Matlab OPC Toolbox

Audio/Video

- Vidyo
- WebEx
- Matlab + DT
- Tricaster

Customer Clients

- Matlab
- LabVIEW Web UI
- Custom Client

Blue = Most promising near term options

Most Promising Near Term Options

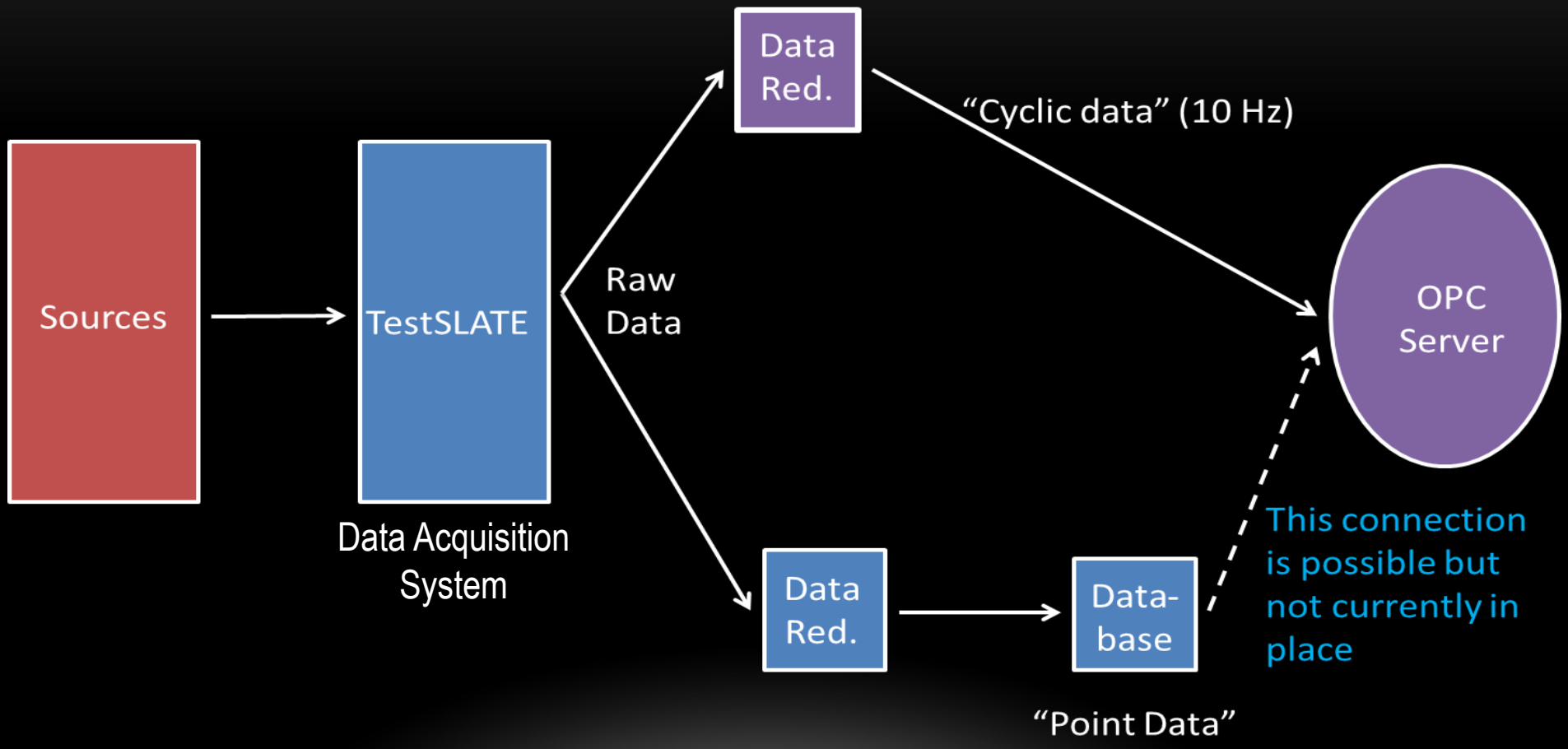
Data

- DataTurbine (DT) + Matlab OPC Toolbox
- aeroCOMPASS

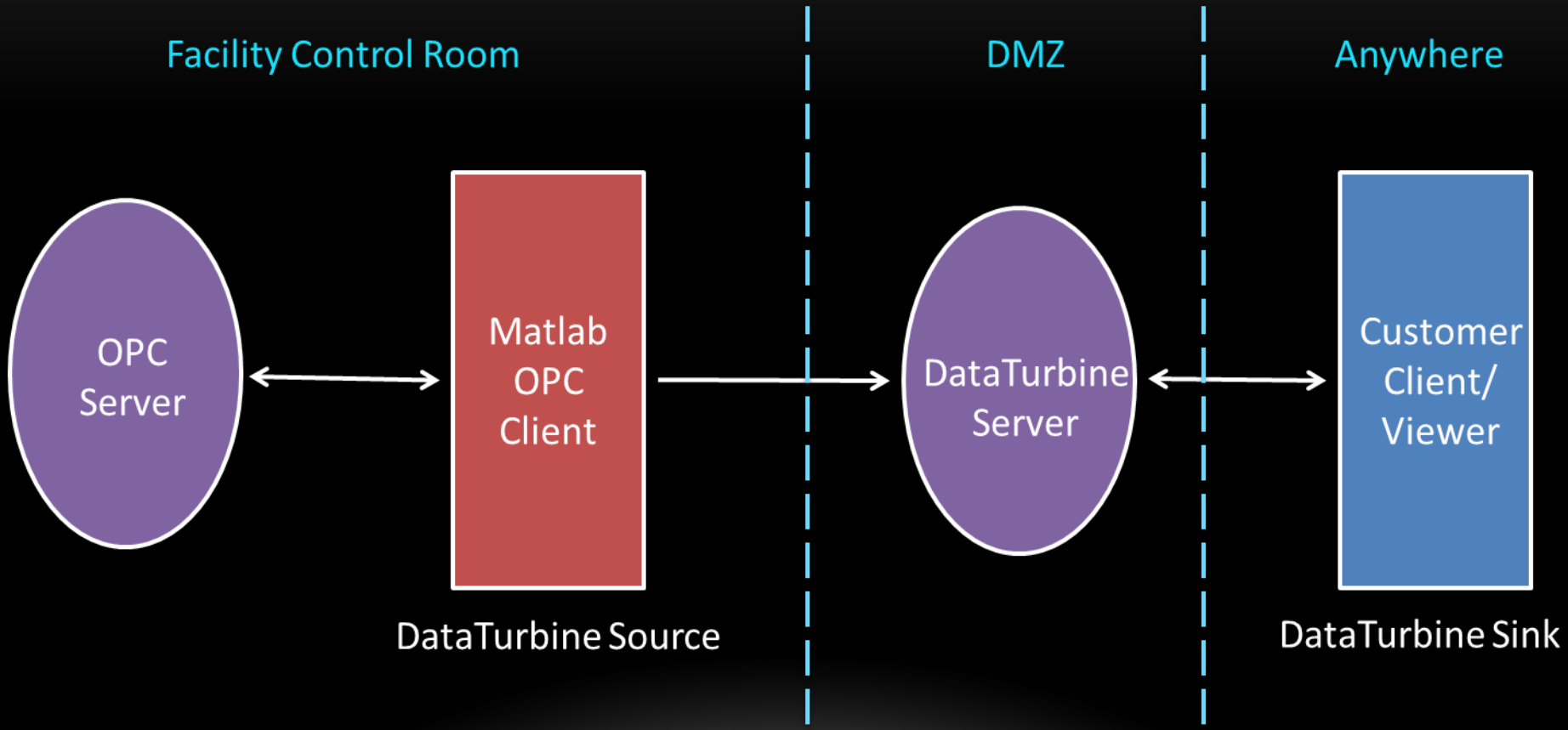
Audio/Video

- Matlab + DT
- VLC + DT
- FFMPEG + DT
- Vidyo
- WebEx

TestSLATE Aeronautic Data Flowchart



Getting Data to Remote Customers

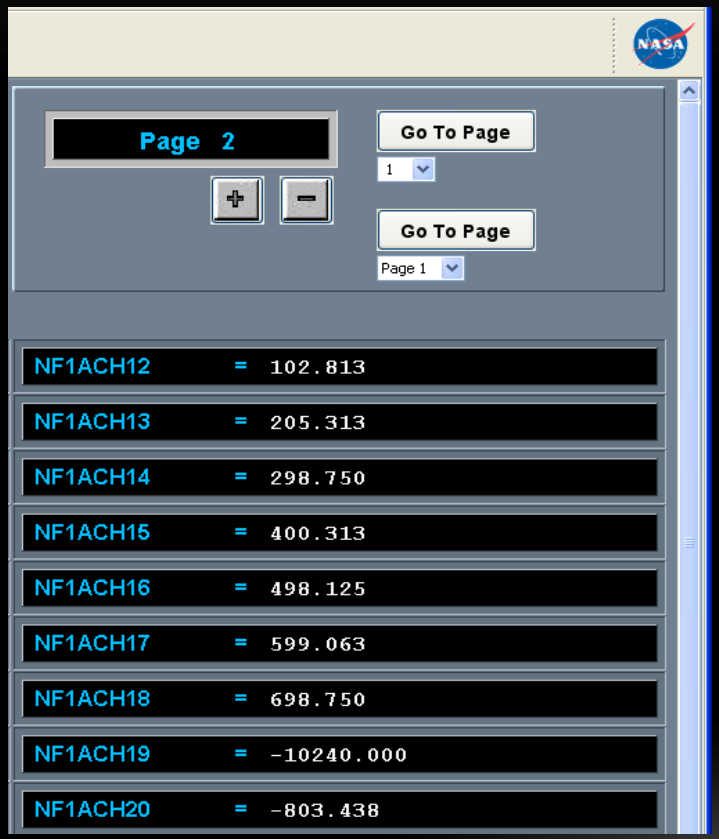


Example of Remote Presence System—Configuration File

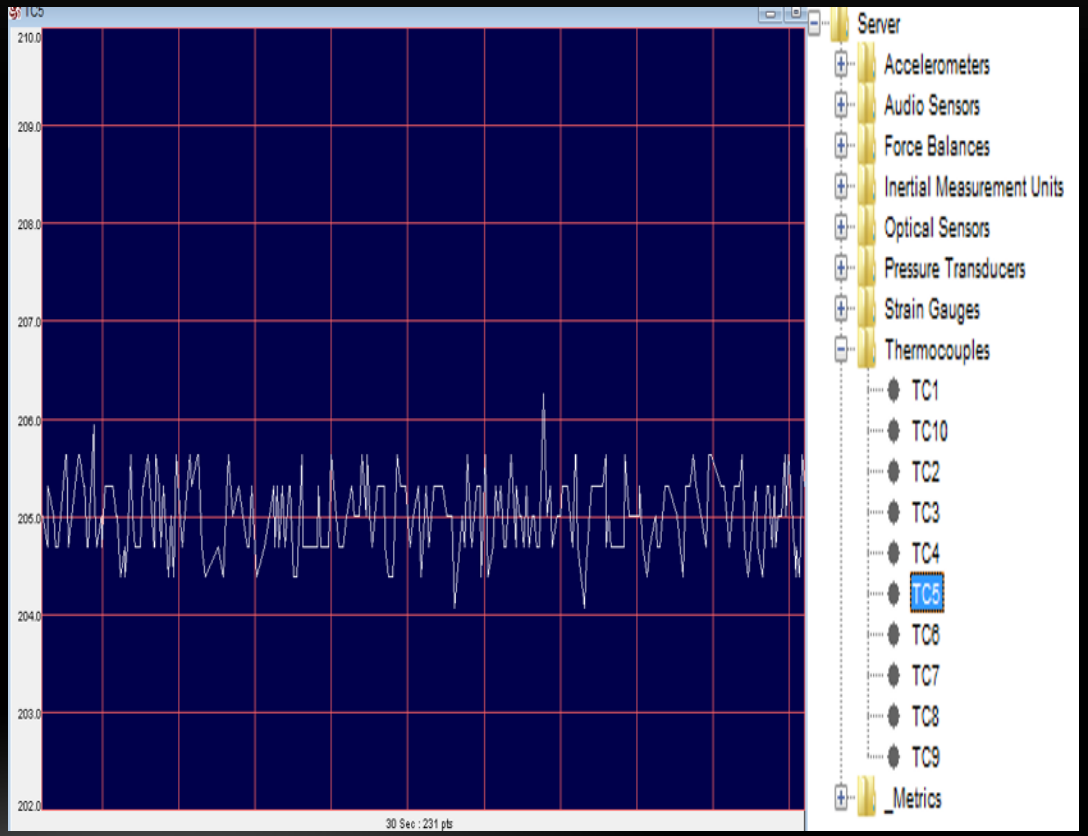
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Source	SGCN	SGFTN	TCCN	TCFTN	PTCN	PTFTN	FBCN	FBFTN	OSCN	OSFTN	ASCN	ASFTN	ACCN	ACFTN	IMCN	IMFTN
2	Strain Gauges	SG01	Data.AI.NF1ACH01	TC1	Data.AI.NF1ACH09	PT1	Data.AI.NF1ACH19	FB01	Data.AI.NF1ACH24	OS01	Data.AI.NF1ACH39	AS01	Data.AI.NF1ACH51	AC1	Data.AI.DTC01P01	IM1	Data.AI.DTC01P07
3	Thermocouples	SG02	Data.AI.NF1ACH02	TC2	Data.AI.NF1ACH10	PT2	Data.AI.NF1ACH20	FB02	Data.AI.NF1ACH25	OS02	Data.AI.NF1ACH40	AS02	Data.AI.NF1ACH52	AC2	Data.AI.DTC01P02	IM2	Data.AI.DTC01P08
4	Pressure Transducers	SG03	Data.AI.NF1ACH03	TC3	Data.AI.NF1ACH11	PT3	Data.AI.NF1ACH21	FB03	Data.AI.NF1ACH26	OS03	Data.AI.NF1ACH41	AS03	Data.AI.NF1ACH53	AC3	Data.AI.DTC01P03	IM3	Data.AI.DTC01P09
5	Force Balances	SG04	Data.AI.NF1ACH04	TC4	Data.AI.NF1ACH12	PT4	Data.AI.NF1ACH22	FB04	Data.AI.NF1ACH27	OS04	Data.AI.NF1ACH42	AS04	Data.AI.NF1ACH54	AC4	Data.AI.DTC01P04	IM4	Data.AI.DTC01P10
6	Optical Sensors	SG05	Data.AI.NF1ACH05	TC5	Data.AI.NF1ACH13	PT5	Data.AI.NF1ACH23	FB05	Data.AI.NF1ACH28	OS05	Data.AI.NF1ACH43	AS05	Data.AI.NF1ACH55	AC5	Data.AI.DTC01P05		
7	Audio Sensors	SG06	Data.AI.NF1ACH06	TC6	Data.AI.NF1ACH14			FB06	Data.AI.NF1ACH29	OS06	Data.AI.NF1ACH44	AS06	Data.AI.NF1ACH56	AC6	Data.AI.DTC01P06		
8	Accelerometers	SG07	Data.AI.NF1ACH07	TC7	Data.AI.NF1ACH15			FB07	Data.AI.NF1ACH30	OS07	Data.AI.NF1ACH45	AS07	Data.AI.NF1ACH57				
9	Inertial Measurement Units	SG08	Data.AI.NF1ACH08	TC8	Data.AI.NF1ACH16			FB08	Data.AI.NF1ACH31	OS08	Data.AI.NF1ACH46	AS08	Data.AI.NF1ACH58				
10				TC9	Data.AI.NF1ACH17			FB09	Data.AI.NF1ACH32	OS09	Data.AI.NF1ACH47	AS09	Data.AI.NF1ACH59				
11				TC10	Data.AI.NF1ACH18			FB10	Data.AI.NF1ACH33	OS10	Data.AI.NF1ACH48	AS10	Data.AI.NF1ACH60				
12								FB11	Data.AI.NF1ACH34	OS11	Data.AI.NF1ACH49						
13								FB12	Data.AI.NF1ACH35	OS12	Data.AI.NF1ACH50						
14								FB13	Data.AI.NF1ACH36								
15								FB14	Data.AI.NF1ACH37								
16								FB15	Data.AI.NF1ACH38								

Example of Remote Presence System—Data

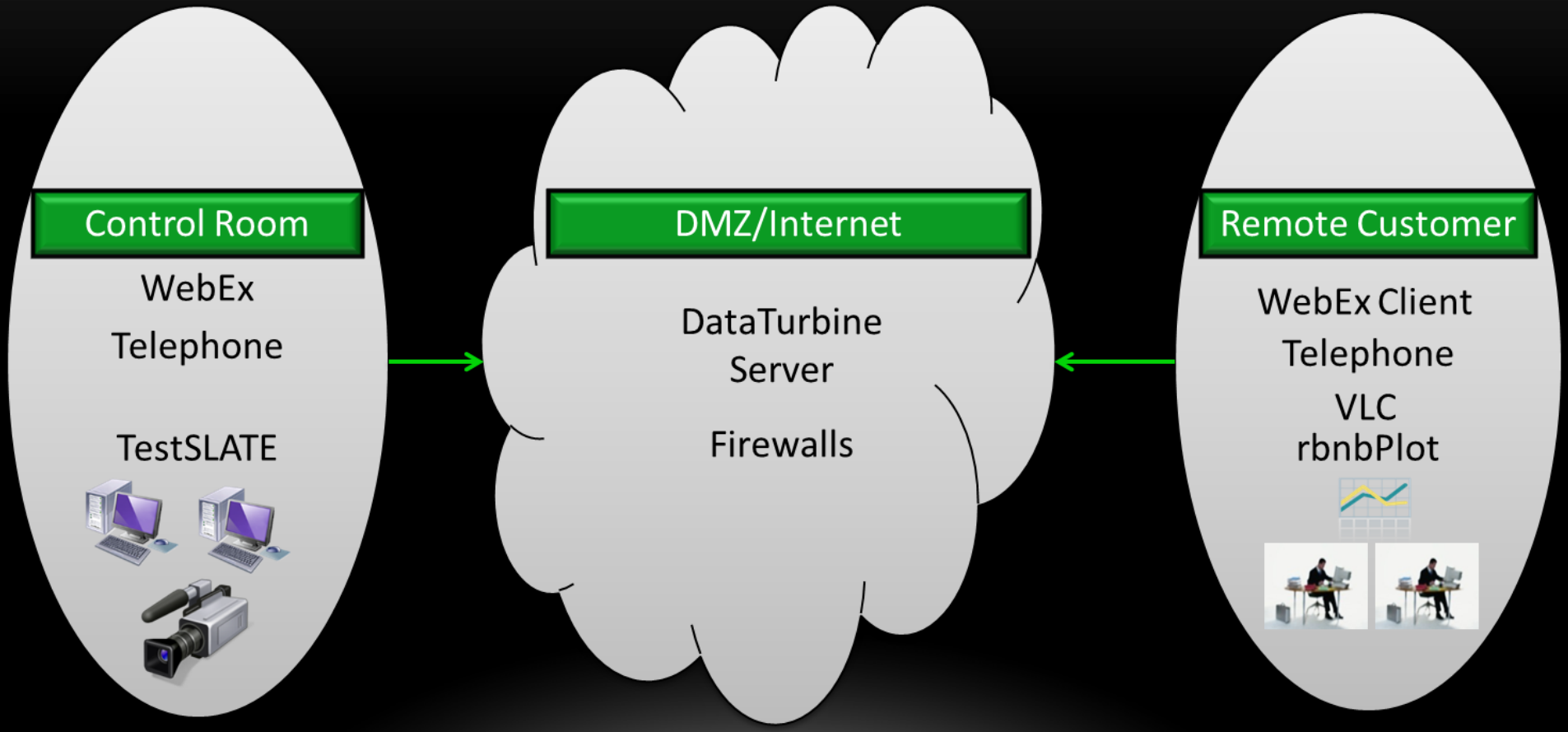
DAS/Control Room View



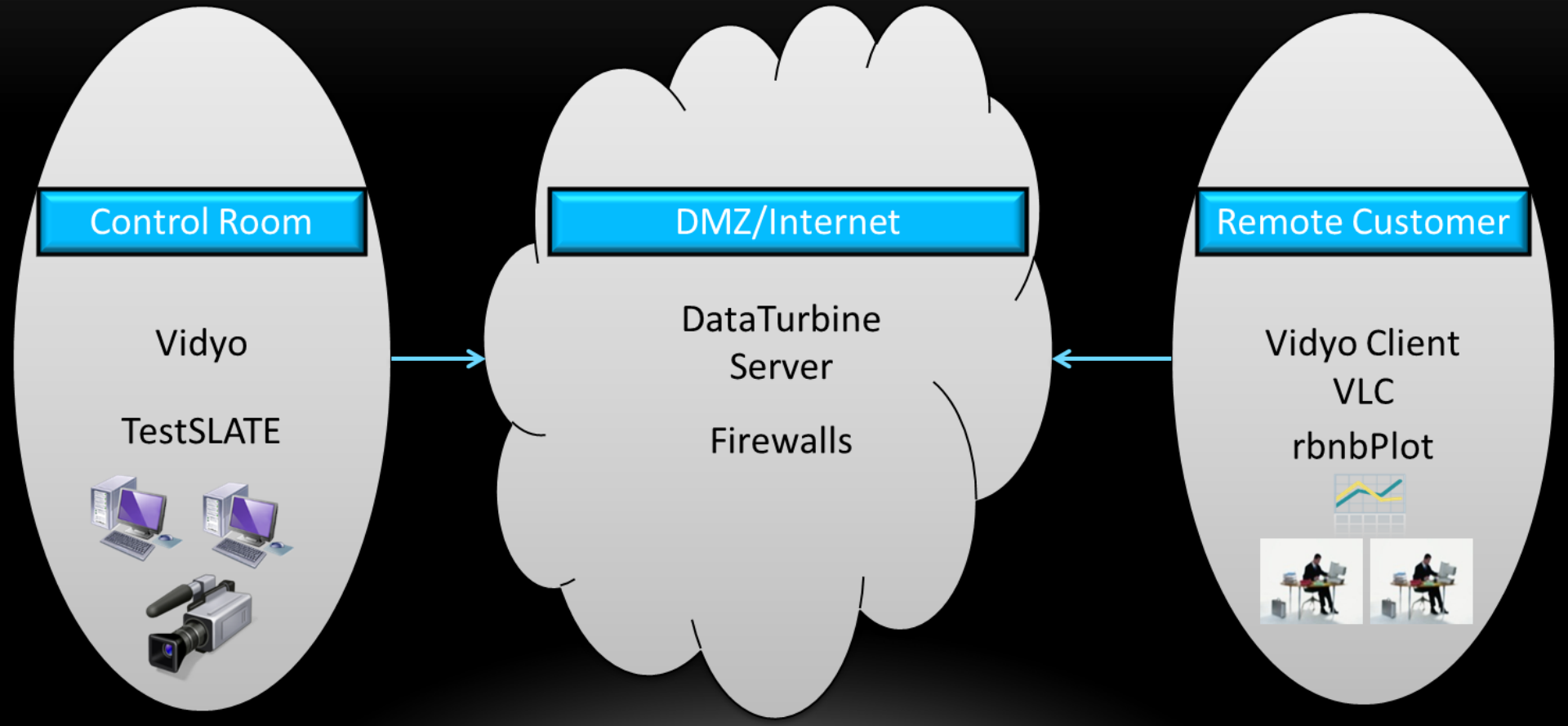
Remote Client View



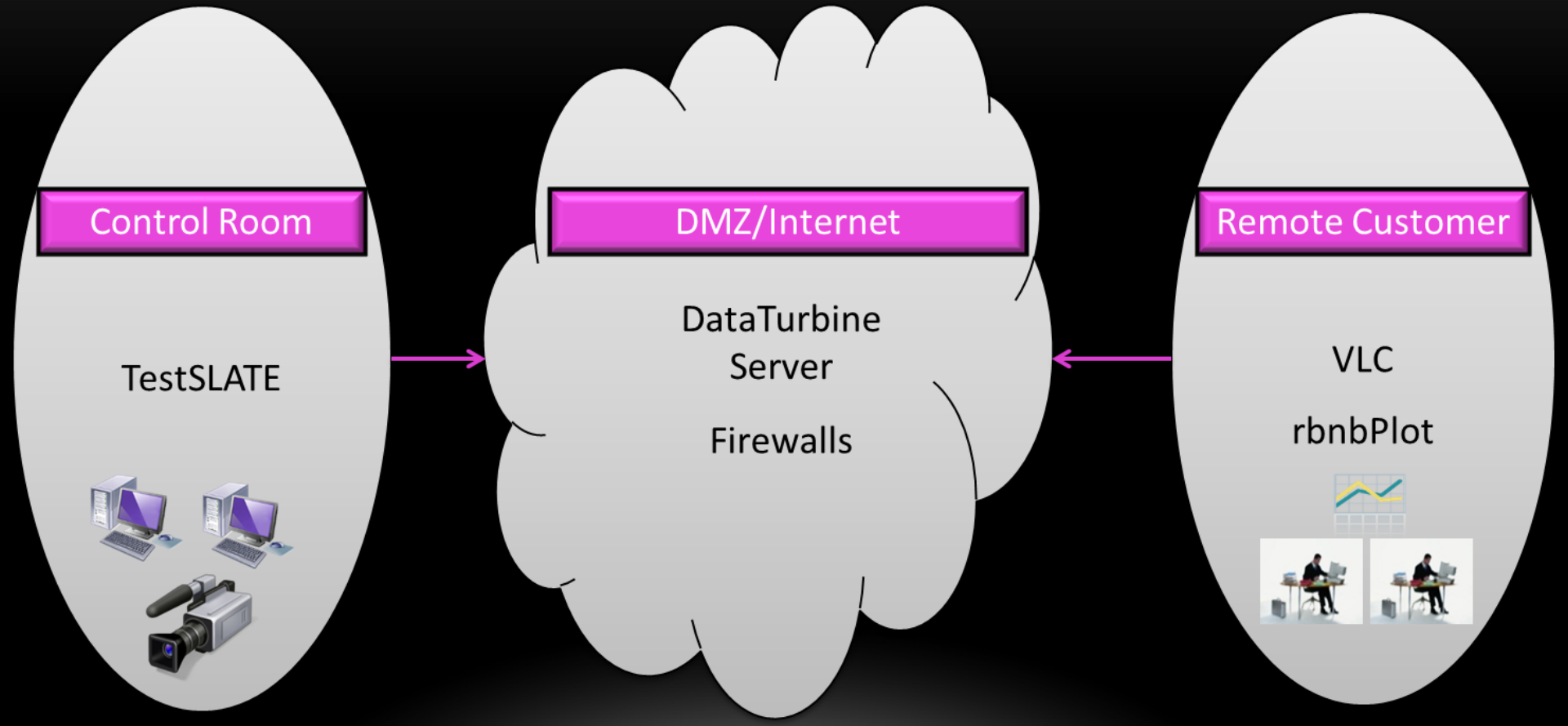
Potential Application with WebEx



Potential Application with Vidyo



Potential Application with DataTurbine



Issues That Need To Be Understood

- Security concerns from multiple perspectives
  - Technical
    - DataTurbine doesn't currently have a way to be encrypted
    - Can it be used from facility to facility with minimal change?
    - What does it take to provide a 'menu' of data formats? (DataTurbine can present 'anything,' but how do we get it in/out?)
  - Cultural
    - Specific facility policies on when data is released to customers
    - Breaking the mold—People may not see benefit in the short term
  - Institutional
    - Agency policy and physical network architecture

Resources That Need To Be Considered

- Ease of Use/Training
  - End user perspective
    - What do I need to download?
  - Facility perspective
    - How does it get configured?
    - What does it take to run this thing? People with expertise = $$$
      - Needs to be a part of the test planning from initiation

Future Steps

- Data points in aero database presented by OPC
- Is Matlab/OPC the best approach to get from the data acquisition system to DataTurbine?
  - Is it worth the license fee? What are those costs?
  - What would it take/cost to go directly from OPC to DataTurbine? Is that a good option?
  - Would other options like UDP be easier and/or more beneficial?
- Now that we know the general capabilities, refine the clients and capabilities
  - Matlab generalization of the configuration file (ini file)
  - User interface environment enhancements
  - Security studies
  - Encryption possibilities
- Demonstration with non-SBU test in a facility using TestSLATE

Take Home Message

- There are technologies available that can help provide remote presence capabilities
- There are different testing paradigms which would benefit from different tools (real time, hourly, or daily feedback)
- TestSLATE/DataTurbine combination is the low-hanging fruit for introducing this capability to the customers and facility cultures. We still need to understand the practicality of interfacing with the number of different data systems at NASA Langley Research Center
- More investigation is needed to understand the security and flexibility of DataTurbine in Langley's environment for offsite usage in particular