IT Innovation to enable Smarter Ground Systems

Flexible Architecture Session
GSAW 2019

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Key messages:

• Smarter Ground Systems is not a unique “Space” Challenge – It’s a IT, Data Management, Compute, and Analytics challenge

• Leverage Commercial Technology – Private R&D Investment in Data Management for Analytics, ML, HPC, and Cloud are Several Orders of Magnitude more than Government investment in this field.
  – And it’s Moving Fast

• Autonomous IT is here – Autonomous Databases, Autonomous ML, more coming...

• Move the Algorithms – not the Data
  – Moving Data creates Platform Sprawl: Architecture Complexity, Duplicated Data, Data Latency, Data Consistency Issues, Security Exposures, and Duplicated Storage, Backup, Systems, etc/etc

• Evolve towards a combined data management + advanced analytics environment that can analyze data, perform machine learning and essentially “think”

• Don’t throw away historical Data – That’s Machine Learning Training Data!
IT Innovation in Cloud IaaS: NextGen Performance/Security

Gen 1 Clouds

**Shared Computers: User Code + Cloud Control Code**

- Cloud Provider Cannot See Customer Data
- No User Access to Cloud Control Computer or Code
- Performance is equal to or better than “on-premise”

**Shared Cloud Control Computer Vulnerabilities**

- Cloud Provider Can See Customer Data
- User Code Can Access Cloud Control Code

![Shared Cloud Control Computer Diagram]

Gen 2 Cloud

**Separate Cloud Control Computers: No User Code**

- Cloud Provider Cannot See Customer Data
- No User Access to Cloud Control Computer or Code
- Performance is equal to or better than “on-premise”

**Separate Network of Dedicated Cloud Control Computers**

![Separate Cloud Control Computer Diagram]
Revolution in Cloud Network:
Low Latency, High Bandwidth RDMA Cluster Networking

- Bare Metal RDMA and GPUs
  - For the hardest product development workloads such as CFD, Crash Simulations, Reservoir Modeling, DNA Sequencing, Deep Learning

- Ultra low latency and high bandwidth
  - For HPC, Databases, Big Data, and AI workloads
  - Cluster 1,000’s of cores on RDMA
  - Supports MPI including IntelMPI and OpenMPI
  - Fastest Time-to-Results

1.5 μs latency, 100Gb/s network
Example of Machine Learning in Industries

• Financial
  – Enterprise Risk Management,
  – Financial Crime and Compliance
  – Credit Score/analysis
  – Customer Relationship/marketing
  – Customer Insight

• Retail B2C
  – Market Basket Analysis
  – Event Based Marketing
  – Purchased X – Recommend Y
  – Customer Segmentation
  – Customer Loyalty
  – Sales Predictions

• Industrial
  – Predictive Fault Monitoring

• Health Care
  – Illness pattern analysis
  – Patient Care & Quality Analysis

• Human Capital Management (HCM)
  – Employee turnover, performance prediction and “What if?” analysis

• Government
  – Threat Detection
  – Cyber/Trend Analysis
  – System Failure prediction
  – Computer Vision
  – Sentiment Analysis

• IT Infrastructure
  – IDAM: Real-time security and fraud analytics
  – Autonomous Database
  – Customer Support: Predictive Incident Monitoring
Data Management & Analytics Architecture

**Data**
- Data Streams
- Social/Log Data
- Enterprise Data
- Other Data Sources

**Fast Data**
- Lake
- Data Factory
- Gold Data

**Data Platform**

**Data Lab**

**APIs**

**Analytics**
- >SQL
  - Big Data SQL

**Query Layer**

**Explore**

**Monitoring & Tipoff**
- Industry Services
- Internet of Things
- Sentiment

**Apps**
- JDBC/ODBC
- Spatial/Graph Tools
- Packaged Apps

**Self Service Query**
- Reporting-oriented
- Often enterprise wide in scope, cross LoB
- “you know the questions to ask”

**Data Discovery**
- Data Exploration
- Highly visual and/or interactive
- “you don’t know the questions to ask”
Potential ML/AI Ground System Resiliency Use Cases

- **TT&C**
  - Platform Telemetry Analysis
  - Anomaly Detection/Prediction

- **Global Ground System**
  - Optimized Worldwide Comm Planning/Scheduling
  - Constellation Orbital Management
  - Anomaly Analysis/Prediction
    - MOC, Backup MOC, Comm Relay & Tracking Sites
    - Uplink/Downlink RF System Fault
    - Pedestal System
    - IT Fault Analysis/Prediction
  - WX degradation/re-plan Prediction

- **Ground Facility**
  - Anomaly Detection
    - Power Plant, Cooling, etc

- **Product Processing**
  - Automated Exploitation
  - Computer Vision
  - Enhance Probability of Detection
  - Anomaly Detection

- **Human Element**
  - Employee turnover, performance prediction and “What if?” analysis
HPC, Machine Learning, and Clouds—Oh My!
Flexible Architectures Summary

• Gen-2 Clouds are available world wide for Performant, Secure, cost-effective infrastructure with HPC networks and GPU shapes

• Machine learning, predictive analytics & “AI” have become must-have capabilities

• Need to evolve towards a combined data management + advanced analytics environment that can analyze data, perform machine learning and essentially “think”

• Leverage Extensive Commercial R&D and Investment
  – Avoid Opportunity Costs of duplicating COTS capabilities
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