# IT Innovation to enable Smarter Ground Systems

Flexible Architecture Session
GSAW 2019

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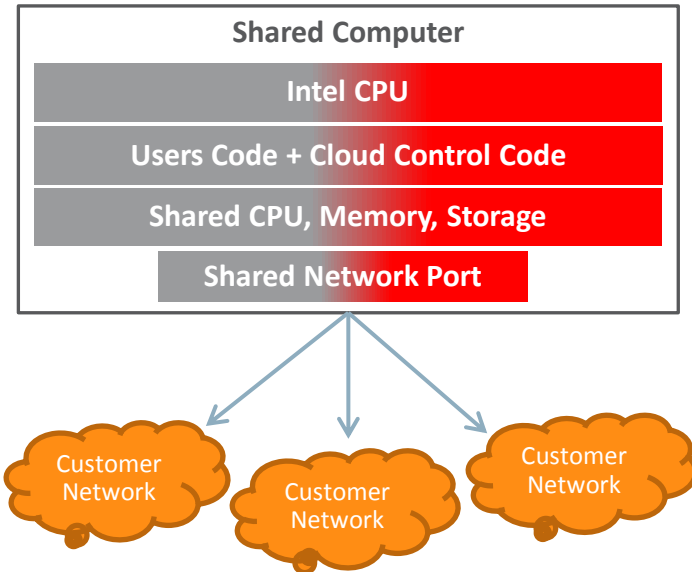
# Key messages:

- 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!

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# IT Innovation in Cloud IaaS:  NextGen Performance/Security

## Gen 1 Clouds

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

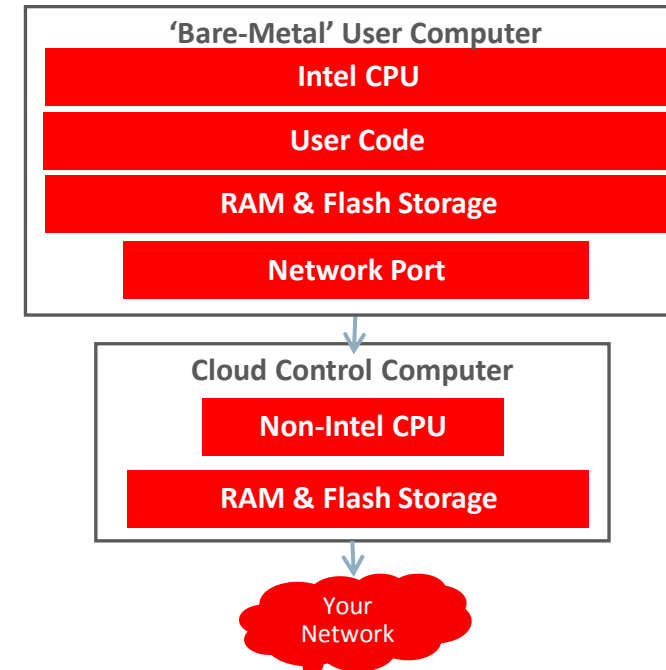| Shared Computer |
| --- |
| **Intel CPU** |
| **Users Code + Cloud Control Code** |
| **Shared CPU, Memory, Storage** |
| **Shared Network Port** |

Customer Network

Customer Network

Customer Network

**Shared Cloud Control Computer Vulnerabilities**

- Cloud Provider Can See Customer Data

- User Code Can Access Cloud Control Code

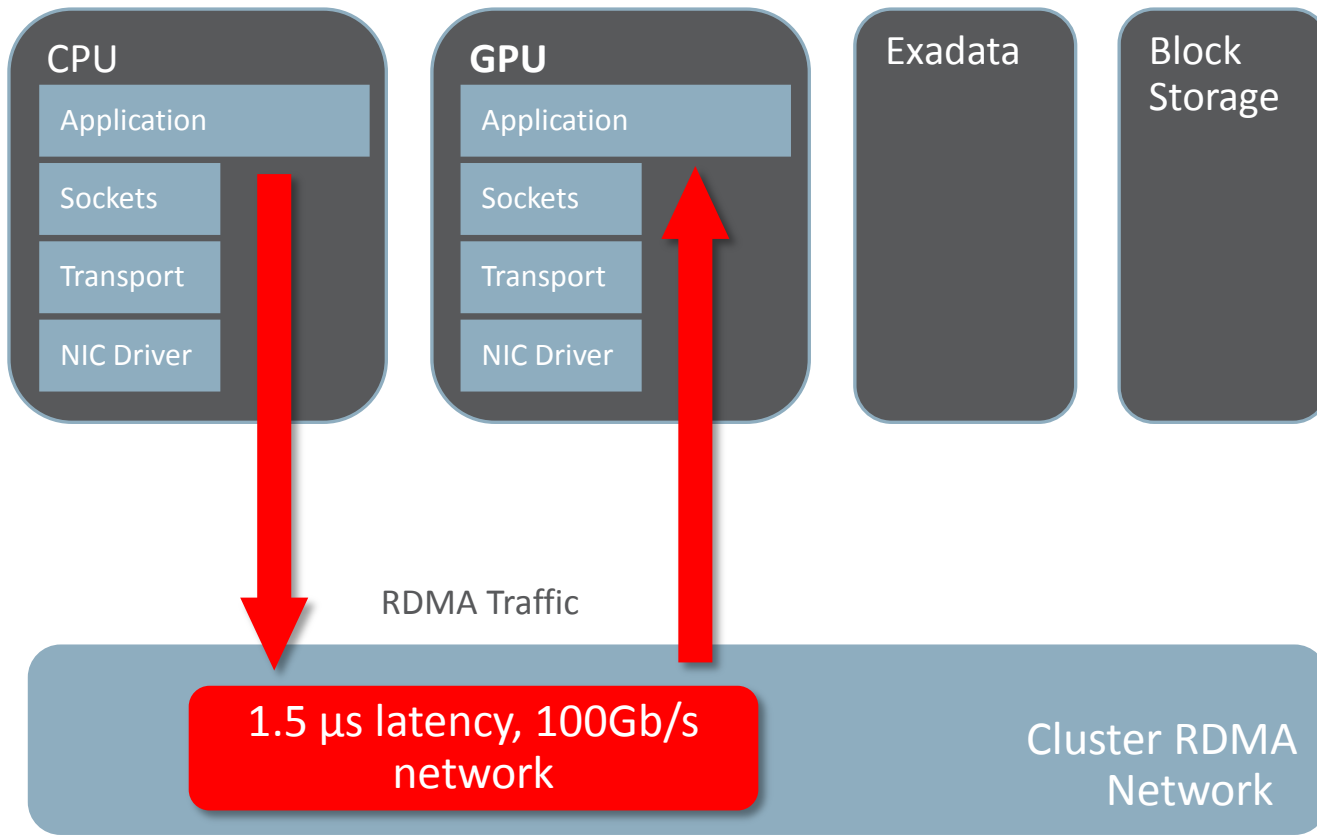## Gen 2 Cloud

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

| 'Bare-Metal' User Computer |
| --- |
| **Intel CPU** |
| **User Code** |
| **RAM & Flash Storage** |
| **Network Port** |

| Cloud Control Computer |
| --- |
| **Non-Intel CPU** |
| **RAM & Flash Storage** |

Your Network

**Separate Network of Dedicated Cloud Control Computers**

- Cloud Provider Cannot See Customer Data

- No User Access to Cloud Control Computer or Code

- Performance is equal to or better than "on-premise"

# Revolution in Cloud Network:
## Low Latency, High Bandwidth RDMA Cluster Networking

**CPU**
- Application
- Sockets
- Transport
- NIC Driver

**GPU**
- Application
- Sockets
- Transport
- NIC Driver

Exadata

Block Storage

RDMA Traffic

1.5 μs latency, 100Gb/s network
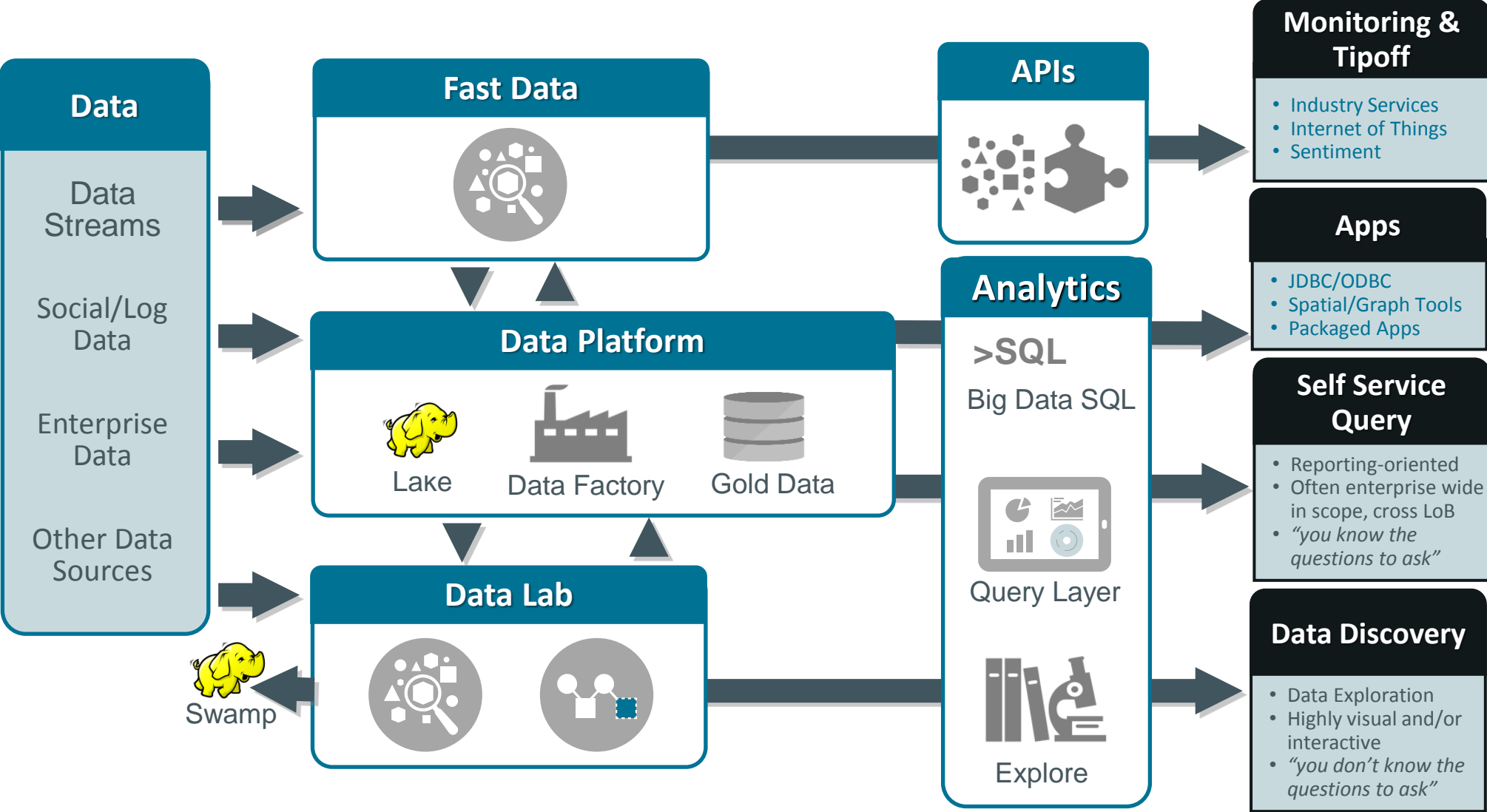
Cluster RDMA Network

- 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

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# 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**

**Data Platform**
- Lake
- Data Factory
- Gold Data

**Data Lab**

Swamp

**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"*

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# 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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