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STUDENT FOCUSED • LAND GRANT • RESEARCH UNIVERSITY

NDSU Research and Creative Activity

Presentation to ND Interim Economic Impact Committee

Kelly A. Rusch, Ph.D., P.E.
Vice President

High Performance Computing to Enhance the Research Activity of North Dakota Universities

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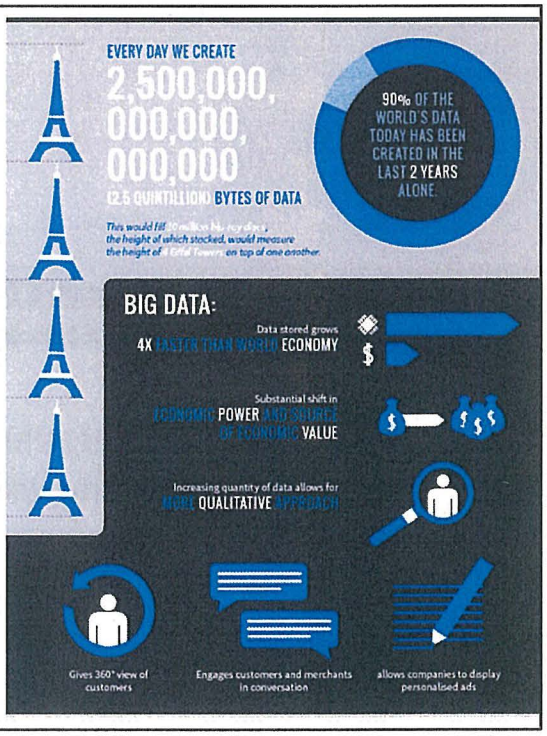
Amount of Data Produced Daily



Ben Walker, Marketing Executive, Vouchercloud; taken from http://www.vcloudnews.com/every-day-big-data-statistics-2-5-quintillion-bytes-of-data-created-daily/; April 5, 2015

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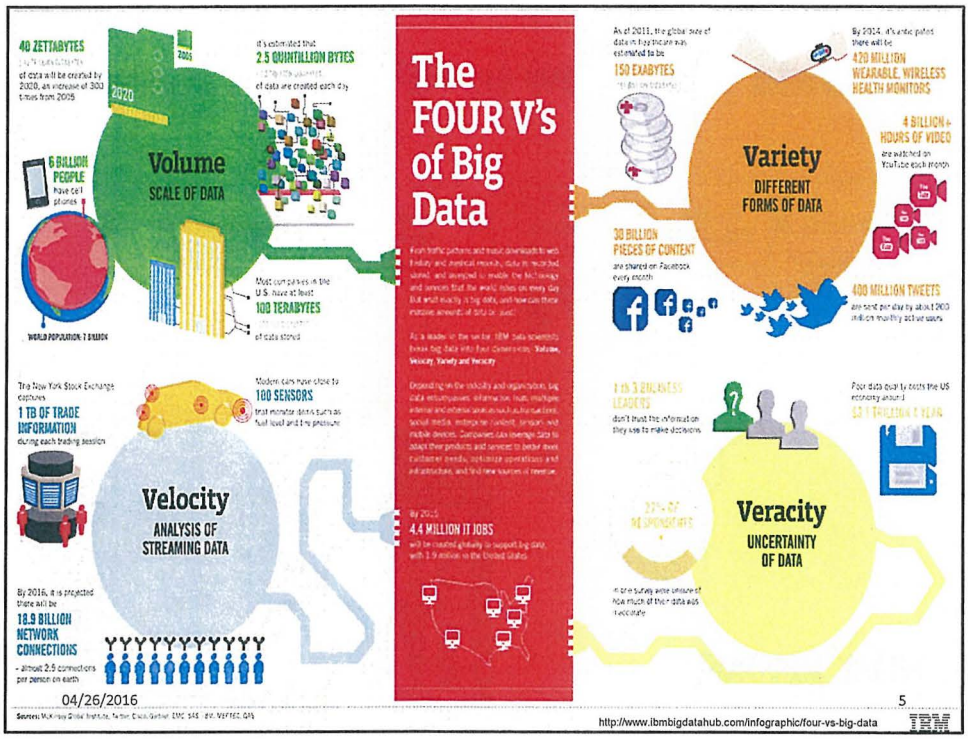
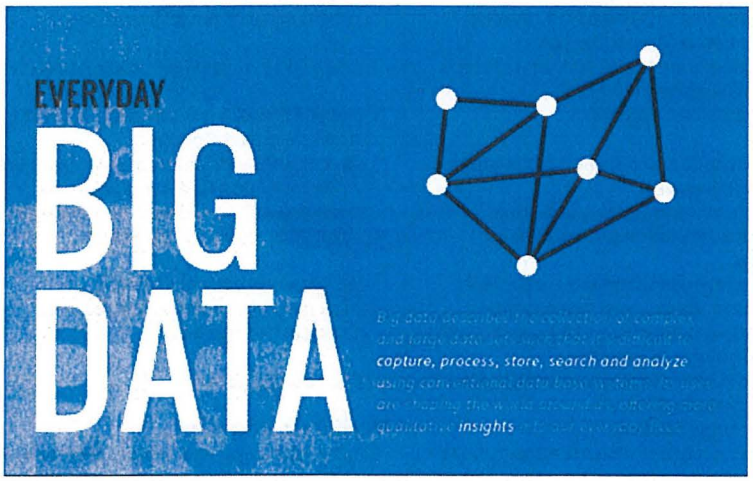


http://www.ibmbigdatahub.com/infographic/four-vs-big-data

IBM

High Performance and Advanced Computing Opportunities



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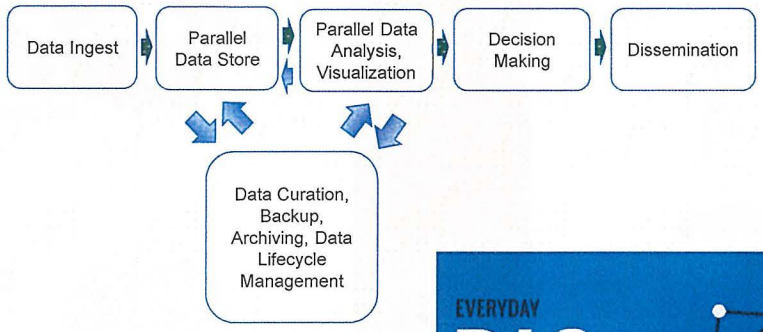
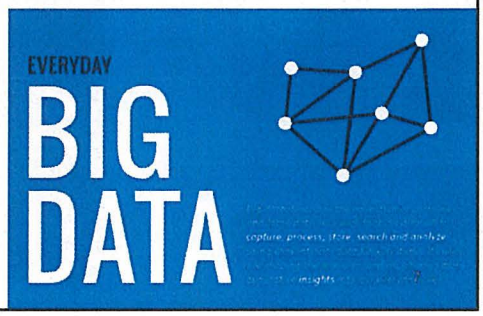
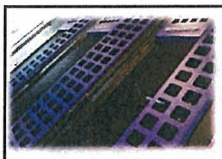
Big-data Workflow in HPC Environment



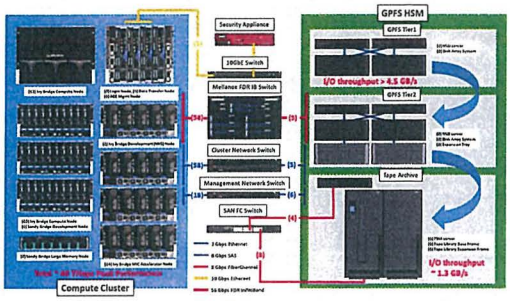


HPC Datacenter	Administrative Computing Datacenter
• High density, often smaller areal footprint	• Lower density, often large areal footprint
• Use of distributed memory cluster computers	• Use of single servers
• High-speed interconnect networks inside the datacenter. Static networks.	• Low speed interconnect networks inside datacenter. Software defined networks.
• Parallel processing using MPI (message passing interface) and OpenMP.	• Mostly serial or threads processing
• Knowledge of parallel processing, scaling, etc. a must among HPC staff.	• Knowledge of parallel processing rarely required.
• Use of parallel file systems	• Parallel file systems rarely used. Mostly local or network attached storage.
• Use of schedulers and resource managers	• Use of SaaS (software as a service) model
• Sysadmin intensive	• Administration easily automated
• Sysadmins highly trained, specialized	• Sysadmins with varied level of sophistication
• Emphasis on performance/capability computing	• Emphasis on capacity computing
• Profiling and optimization are daily tasks	• Applications usually ran "as is"
• Often runs home grown scientific apps	• Mostly runs "canned" applications
• Architecting procuring and integrating new hardware solution is common	• Off-the-shelf hardware
• Advanced user support and computational PhD domain scientists	• Basic user support
• Equipment very costly	• Equipment less costly
• Wide cross section of executed applications	• Limited number of executed applications



Center for Computationally Assisted Science and Technology (CCAST)

Next-generation Data-intensive Cyberinfrastructure for Research and Education (BigThunder)



Blue – compute subsystem

Interconnect

Green – I/O and storage subsystem

Thunder Architecture

- Emphasis on data flow and Input/Output (I/O) capabilities on high-velocity, high-variability "big data"
- "Oversized" tiered parallel file systems (up to ~750 Terabytes) and active-archive tape storage (~4 Petabytes uncompressed)
- Modular design for easy expansion
- ~2,300 compute cores
- ~36 Teraflops and ~18 million schedulable CPU hours/year

FY15 Data [from all 4 clusters]

- 176 user accounts (60 active users)
- Provided ~50 Teraflop performance and ~30 million schedulable processor-hours/year
- Enabled 45 publications, 35 talks/presentations, 32 proposals (4 funded), 4 MS and 2 PhD theses

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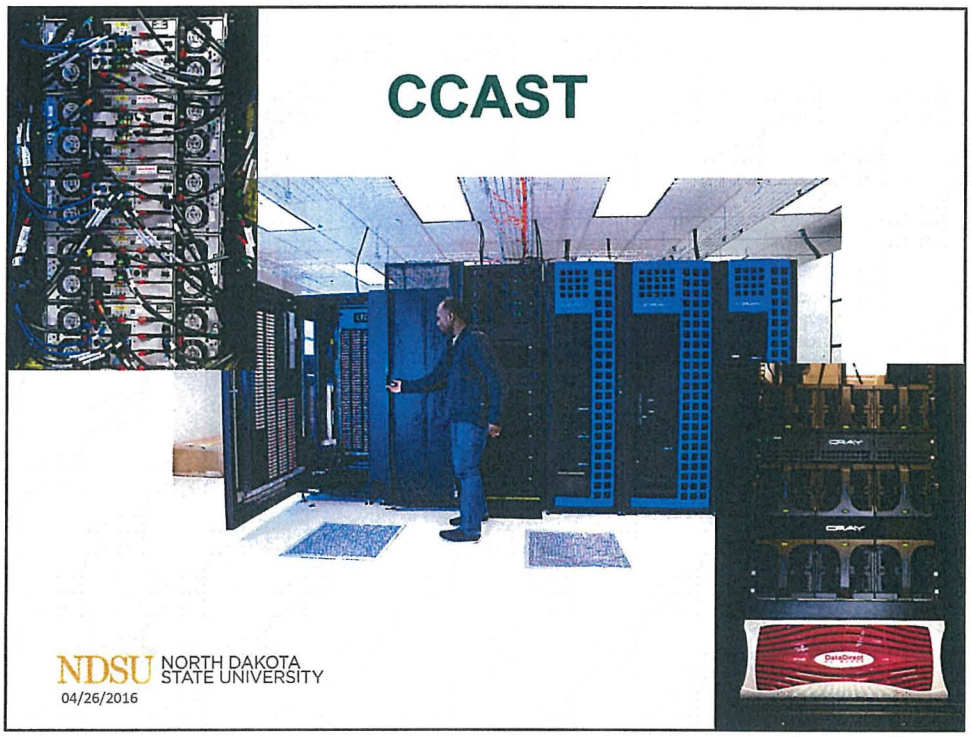
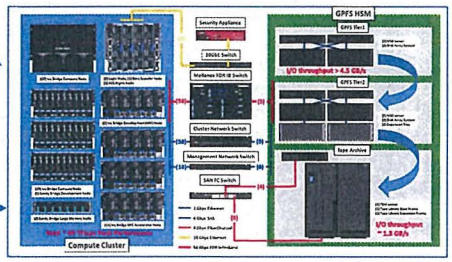
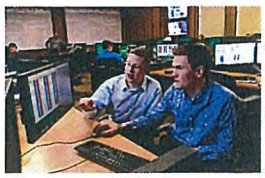
On-ramp to leadership-class national facilities [XSEDE-NSF; INCITE-DOE and OSG-NSF/DOE]







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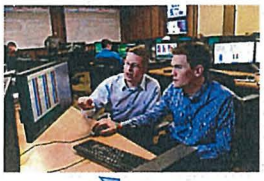
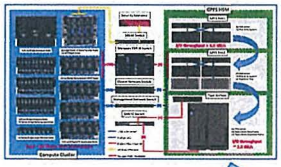
UAS Dataflow Dimension



A large UAS multispectral camera payload is capable of returning 500,000 individual images resulting in a mosaic of 5,000 x 2 GB tiles for a total of 10 TB (terabytes) <u>in a single day.</u>



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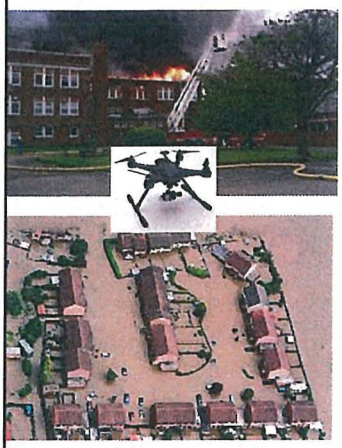
Products for First Responders



- Technology needed for first responders to sense the presence of persons though visually obscure barriers.
- Ability to deploy sensor from sUAS and monitor it from standoff distance

Cyclops / NDSU Team: Develop sensor product for small UAS application

Technology Approach: - Integrated Bi-modal sensor: through the wall sensor [radar] + RF signal detector [e.g., cell phone]

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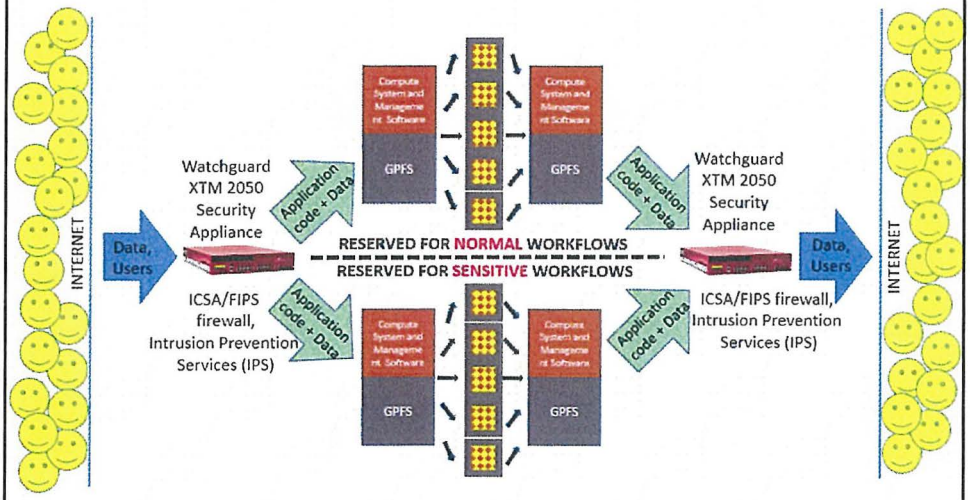
CCAST Security and Physical Separation of Resources



Examples of Research Enabled by High Performance Computing

UAV OPPORTUNITIES SOAR IN NORTH DAKOTA

The New York Times calls North Dakota "**A Silicon Valley for Drones.**" UAV opportunities in the state are soaring as teams at NDSU focus on unmanned aerial vehicle research, particularly in precision agriculture. NDSU projects include data collection for crop management with infrared, thermal, color and multi-spectral imagery. NDSU's Center for **Computationally Assisted Science** and Technology assists in analyzing collected data.

NDSU's UAV team includes representatives from its colleges, providing multidisciplinary expertise in **UAV research**. North Dakota's one-team approach provides an unparalleled unmanned aerial systems research environment through partners in the Northern Plains Unmanned Aircraft Systems **Test Site**. The FAA gave approval to the Test Site for drones to fly up to 1,200 feet above the entire state, including night flights, allowing UAV opportunities to continue to expand in the state.