#### GPU TECHNOLOGY CONFERENCE

#### GPU-ACCELERATED PLATFORM TRANSFORMING THE SMART CITIES LANDSCAPE

PRADEEP GUPTA SENIOR SOLUTIONS ARCHITECT, NVIDIA

### Agenda

Smart City - Concept and Motivation NVIDIA's Platform for Making Smart Cities Use Cases Future Directions

### Smart City - Concept and Motivation

#### The World is now on the verge of complete urbanization



4 📀 NVIDIA.

Source: Anatomy of a Smart City, Postscapes (http://postscapes.com/anatomy-of-a-smart-city-full)

#### Lets see how Urbanization has changed Singapore?







#### Singapore MRT - Lifeline of SG Transport



MRT opened in 1987 and this was 1989-1996 system

#### Singapore MRT - Lifeline of SG Transport



#### MRT in 2015

Problems created by Urbanization



Image -http://cdn.citylab.com/media/img/citylab/2013/03/19/urbanizationmain 1/lead large.jpg

### HOW CAN WE SOLVE THIS PROBLEM

### CAN SMART CITIES DO THAT?

#### LETS SEE WHAT IS A SMART CITY

#### Smart City Concept of Smart City



Image Courtesy- http://smartcities.ieee.org/images/files/images/wordcloud\_smartcityjam.png

### SMART CITY OVERVIEW



#### Smart City What are Key Components



Image and Contents courtesy - IDA Singapore Smart Nation Documents

#### Smart City Key Technologies



### **NVIDIA's Platform for Smart Cities**

### The Most Versatile GPU Accelerated Platform For The Data centre



Flexible Pascal & NVLink Architecture for DataCentre



#### Smart City Key Technologies

Flexible Pascal & NVLink Architecture for DataCentre

CUDA Platform for Accelerated Computing

cuDNN accelerating Deep learning on GPUs

**GPUs in Cloud** 

Professional Visualization with IRAY

vGPU powering GPU virtualization



**NVIDIA Visual Computing - NV Platform for Smart Cities** 

### Use Cases

### Intelligent Video Analytics with GPUs

### Many pixels, not much insight



200 Million surveillance cameras deployed WW



**1.4 Trillion** video-hours captured per year





**1.2 Billion** PCs, phones, tablets have cameras

#### HOW DO WE INTERPRET & ACT ON THESE PIXELS?

### Data and insight from video



Conversion: Process video to extract meaningful quantities or features of interest

**Evaluate:** Identify metrics, trends, Compare and contrast video data with what is normal or not, compare with other camera streams

Map / Visualize: Articulate analysis results and offer tools to that maximize the possibility for data exploration, understanding, and reduced time to action



### NVIDIA Technology Backbone





## IVA for Singapore Smart Nation

#### GPUs adding value



### Deep Learning with GPUs

### Practical deep learning examples

Image Classification, Object Detection, Localization, Action Recognition, Scene Understanding



Pedestrian Detection, Traffic Sign Recognition



Speech Recognition, Speech Translation, Natural Language Processing





Breast Cancer Cell Mitosis Detection, Volumetric Brain Image Segmentation





### Practical deep learning examples



## Impact of GPUs on Deep Learning

<sup>6</sup> Training one of our deep nets for auto-tagging on a single NVIDIA GeForce GTX Titan X takes about sixteen days, but using the new automatic multi-GPU scaling on four Titan X GPUs training completes in just five days. This is a major advantage and allows us to see results faster, as well letting us more extensively explore the space of models to achieve higher accuracy."

- Simon Osindero, A.I. Architect at Yahoo's Flickr

"We believe FP16 storage support in NVIDIA's libraries will enable us to scale our models even further, since it will increase effective memory capacity of our hardware, as well as improve efficiency as we scale training of a single model to many GPUs. This will lead to further improvements in the accuracy of our model."

- Bryan Catanzaro, Senior Researcher at Baidu Research

" NVIDIA's cuDNN library delivers great benefit to the Minerva deep learning framework. We're looking forward to integrating the performance improvements provided by cuDNN 3. We expect the additional performance and support for larger models to allow us extend our research into automated analysis of video and multi-modality learning involving, for example, computer vision and natural language processing."

- Zheng Zhang, Professor of Computer Science at NYU Shanghai, and advisor to the DMLC/Minerva framework







#### **NVIDIA Platform Enabling Virtual City Modeling**

# Virtual City

Target Users



#### Government

Manage population growth

Optimize city development (traffic, energy, ecosystem, citizen well being)

Attract foreign investment



#### Citizens

Monitor property and family members

Benefit from services through a dedicated social network (ex: avoid traffic congestion)



#### Universities/Professional companies

R&D/student training & research on new technologies Create new services and businesses

#### Virtual City Major Goals

Data Management: collect, store and manage big data

Geographical/geodesic/atmospheric Sensor/camera Detailed building architecture Visualize: provide the best visual experience

> Interactive city navigation in 3D Massive amount of data

Simulation: Simulate and add new app/use cases

Flood/crowd simulation

Indoor navigation

RF/noise propagation



### VIRTUAL CITY PLATFORM ENABLEMENT WITH NVIDIA TECHNOLOGY



NVIDIA Technologies

### VIRTUAL CITY PLATFORM ENABLEMENT WITH NVIDIA TECHNOLOGY



#### NVIDIA Platform Enabling Geo Spatial Information systems

### GIS PLATFORM ENABLEMENT WITH NVIDIA TECHNOLOGY





## VISUALIZE Large scale GIS visualization





## ANALYSE Real-Time Geospatial Data Processing

Our ability to create vast amounts of geospatial data has outpaced our ability to leverage the wealth of information this data could provide.

Data is flowing continuously, sensors and emitters are in constant motion, not to mention variations in terrain and weather, both of which can impact data collection.

With GPUs data processing is completed 72x faster and with 12x less cost than with CPU-only system.

Now real-time processing of geospatial data enables users to make informed decisions based on timely, actionable information <u>http://www.</u> SRIS (Scheyer Reddy Information Systems)



http://www.nvidia.com/content/tesla/pdf/sris-case-study.pdf

## VIRTUALIZE

#### ArchGIS Pro with NVIDIA GRID in virtualized Environment

- ArcGIS Pro a GIS software package to deliver 2D and 3D data visualization along with spatial analysis
- Great User experience in virtualized environment because of NVIDIA GRID which provides rich graphics experience in virtualized environment.
- Performance Benchmarking

Key Indicators	Results
Frames per Second(rendering pipeline performance)	25-30+
Minimum FPS (sign of subtle pausing or jerkiness)	Lower 20's
GPU utilization on the Host (indicator of VM/GPU density)	~25%
GPU memory utilization on the Host (indicator of VM/GPU density)	~15%

Reference - http://blogs.esri.com/esri/arcgis/2015/03/08/arcgis-pro-in-vmware-horizon-view/

#### **Big Data - GPU Database**

Johor Bahru

MapD

 SQL column-oriented, in-memory database

Demo of 1 Billion Tweets (1 TB) keyword search interactively

✤ 8 Tesla K40 server

Demo:

http://tweetmap.mapd.com/desktop/

Video:

www.youtube.com/watch?v=t4O2yKdfNyg

SINGAPORE

MapD Twitter Demo

### Self Driving Cars with GPUs

#### See the Demo Video @ NVIDIA Booth



### PIXELS IN AUTO DISPLAYS





#### DEEP LEARNING REVOLUTIONIZES VISION



#### DEEP NEURAL NETWORK













#### INTRODUCING NVIDIA DRIVE<sup>™</sup> PX AUTO-PILOT CAR COMPUTER

#### Dual Tegra X1 • 12 camera inputs • 1.3 GPix/sec

- 2.3 Teraflops mobile supercomputer
- Surround Vision
- Deep Neural Network Computer Vision



#### **NVIDIA DRIVE™ PX** DEEP NEURAL NETWORK COMPUTER VISION



#### NVIDIA DRIVE<sup>™</sup> PX SURROUND VISION









### AUTO-VALET PIPELINE



AUTO-PILOT DRIVING INSTRUCTIONS



## **POWERED BY TEGRA X1**



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#### THANK YOU

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