Singapore Overview

Marek T. Michalewicz

A*CRC

michalewiczm@acrc.a-star.edu.sg

BDEC

Barcelona, 29th January 2015

Computational
Resource Centre

A*STAR

National Supercomputer Centre

Joint A*STAR, NUS, NTU, SUTD and NRF Proposal

❖ National Supercomputing Centre (NSCC)
  ➡ New 1-3+ PetaFLOP Supercomputer
  ➡ Recurrent investment every 3-5 years
  ➡ Co-investment from primary stakeholders

❖ Science, Technology and Research Network (STAR-N)
  ➡ A high bandwidth network to connect the distributed compute resources
  ➡ Provide high speed access to users (both public and private) anywhere
  ➡ Support transfer of large data-sets (both locally and internationally)
  ➡ Build local and international network connectivity

Funding (MTI) and co-funding (A*STAR, NUS, NTU) approved Nov. 2014
Tender open 20th January 2015
Tender Closed 14th April
Facility open to users: October 2015

a* Computational Resource Centre
A*STAR

Some features of NSCC Supercomputer

1. Base system: 1-3 PFLOPS

2. Storage - very large, HSM, Tiered, Tier 3 - tape storage (or very cheap, non-spinning disks)

3. I/O comparable to the best systems around (BlueWaters class)

4. Application Software - National license desirable - ISVs, MATLAB, tools e.g. Allinea, NAG

5. 10 Large memory nodes: 5 nodes of 1TBytes, 4 nodes with 2-4TBytes and one node of 6-8TBytes

6. Workflow pipeline (from sequencer to memory/storage) + interactive access built in

7. **500 Gbps pipeline** between Biopolis and Fusionopolis for genomics workflows

8. InfiniBand connection to all end-points (login nodes) at University campuses

9. Just-in-time resource delivery i.e. *interactive access* for some workloads (genomics)

10. Only ~10% nodes GPU accelerated (for some University users, AI work - deep learning)
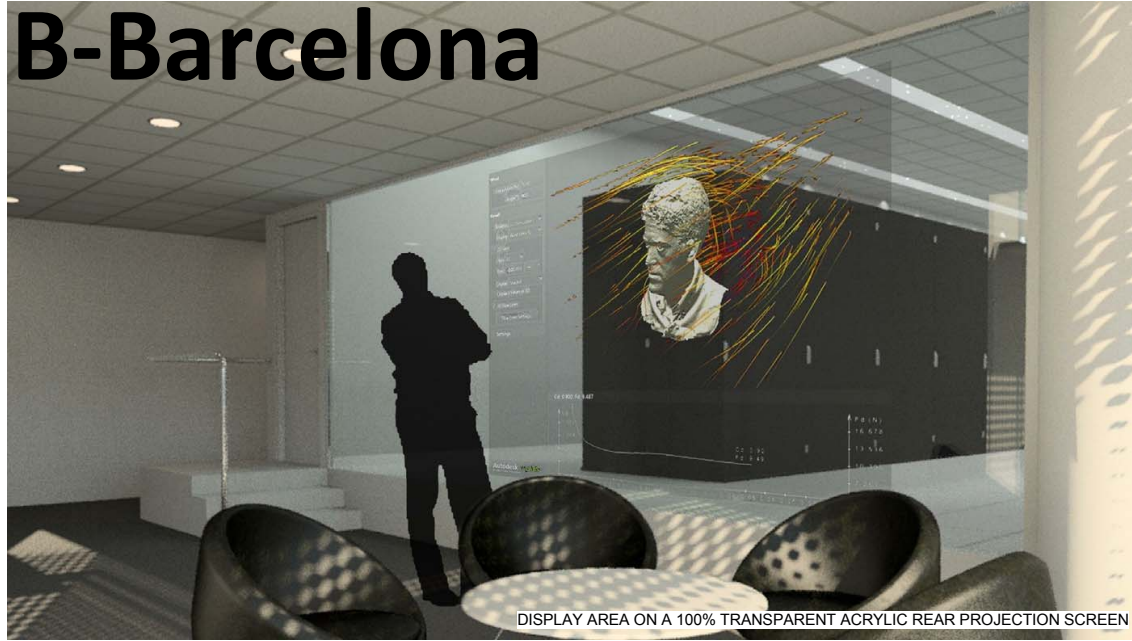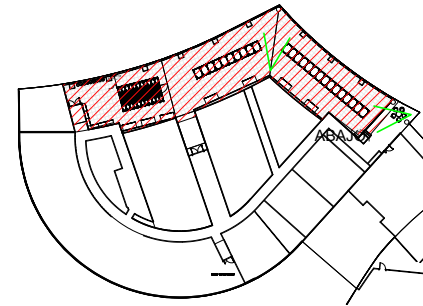
11. Warm water cooled

Computational
Resource Centre
A*STAR

A*CRC Datacenter 1

Level 17 at Fusionopolis

B-Barcelona

SIGHT SEEING WINDOW TO THE DATA CENTER

DISPLAY AREA ON A 100% TRANSPARENT ACRYLIC REAR PROJECTION SCREEN

DATACENTER SIGHT SEEING WINDOW TO SINGAPORE

DOUBLE GLAZZED POLARIZED GLASS FOR THERMAL PROOTECTION

A*CRC Datacenter 1I
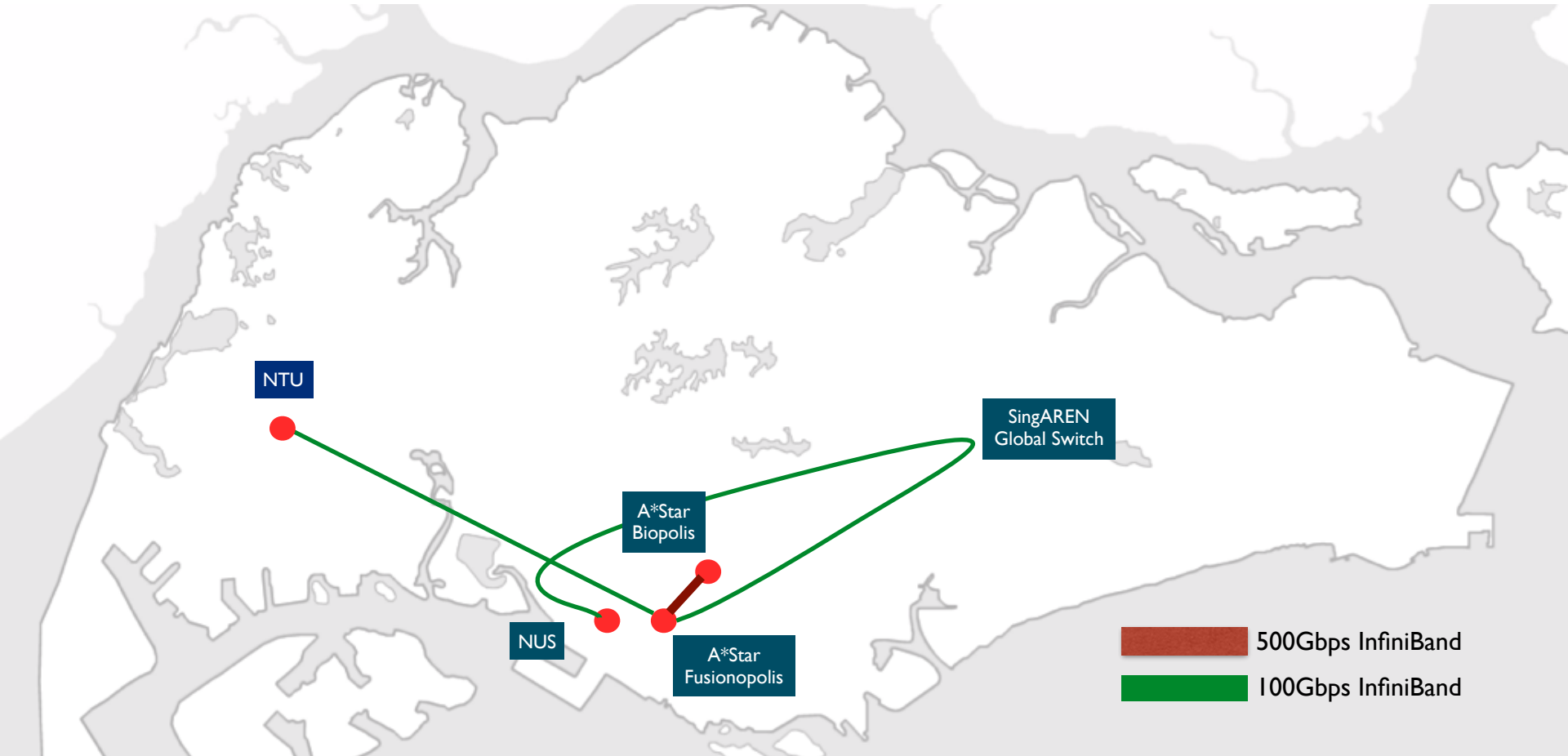

Matrix Building at Biopolis

Metro-X A*CRC team:
Stephen Wong
Tay Teck Wee
Steven Chew

Mellanox Metro-X testing since early 2013

goal: to connect HPC resources at Fusionopolis with storage and genomics pipeline at Biopolis - Matrix building

Computational Resource Centre
A*STAR

Singapore InfiniNet

500Gbps InfiniBand

100Gbps InfiniBand

Objective:
To connect all National Supercomputing Centre stakeholders: A*STAR, NUS, NTU and others with 100Gbps + InfiniBand links.

InfiniCortex:

A path to reach Exascale concurrent supercomputing across the globe utilising trans-continental InfiniBand
and
Galaxy of Supercomputers

Marek T. Michalewicz

A*CRC

michalewiczm@acrc.a-star.edu.sg

BDEC

Barcelona, 29th January 2015

Computational
Resource Centre

A*STAR

The InfiniCortex Components

1. ACA 100

Asia Connects America 100 Gbps, by November 2014

Challenge issued by Yves Poppe at APAN 37 in Budung, Indonesia, 20 Jan 2014

2. InfiniBand over trans-Pacific distance

Made possible with Obsidian Strategics Longbow range extenders

3. Galaxy of Supercomputers + BGFC

Supercomputer interconnect topology work

by Y. Deng, M. Michalewicz and L. Orlowski

Obsidian Strategics Crossbow InfiniBand router (BGFC)

4. Application layer

from simplest file transfer: dsync+

to complex workflows: ADIOS, multi-scale models

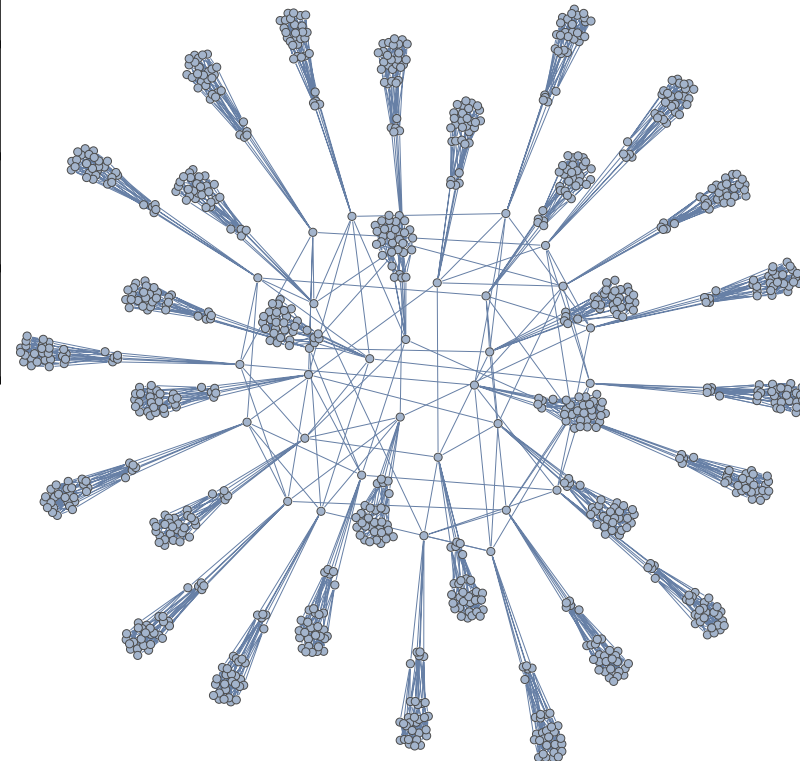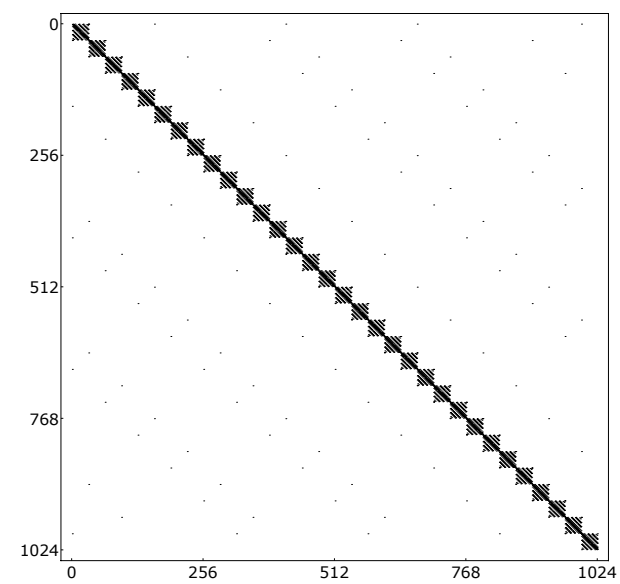Computational
Resource Centre

A ✶ S T A R

Galaxy of Supercomputers

- Supercomputers located at different geolocations connected into a ***Nodes of Super-Network (Super-Graph)***

- Supercomputers may have arbitrary interconnect topologies

- Galaxy of Supercomputers is a topological concept and is based on a topology with small diameter and lowest possible link number

- In terms of graph representation it may be realised as ***embedding*** of graphs representing Supercomputers' topologies into a graph representing the Galaxy topology

Computational
Resource Centre
A✱STAR

32k5⊗32k5

Embedding of a 5-connected graph on 32 nodes into itself proves to be comparable to TOFU or 5D torus with equal or similar number of nodes.

Name of topology	Number of nodes	Number of link	Diameter	Mean path length
32k5⊗32k5	**1024**	**2640**	**9**	**6.31**
Tofu (6x5x3)	1080	5400	9	5.04
5D torus (4x4x4x4x4)	1024	5120	10	5
Tofu (4x4x8)	1536	7680	11	5.67

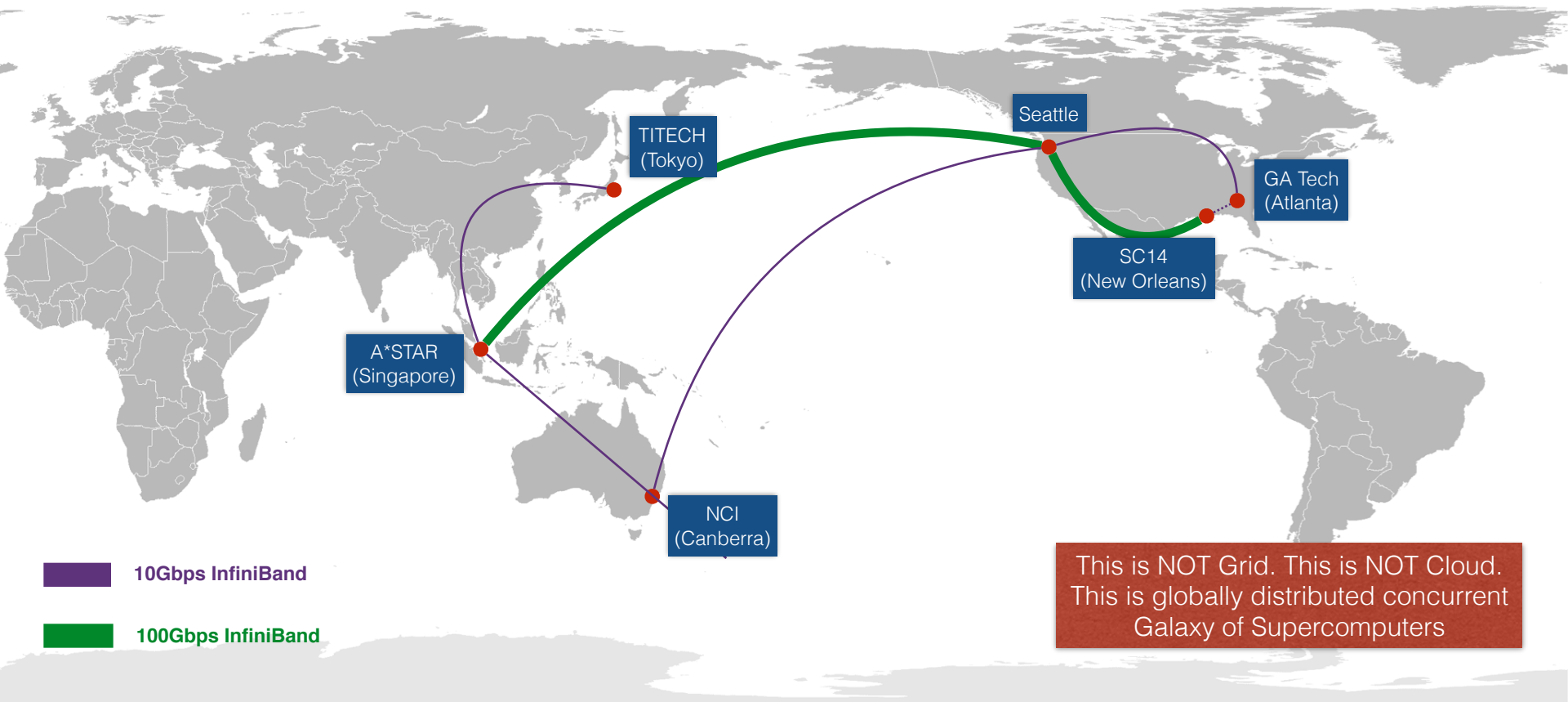

Galaxies of Supercomputers and their underlying interconnect topologies hierarchies

Lukasz P. Orlowski[1], Yuefan Deng[1,2,3] and Marek T. Michalewicz[1]

[1] A*STAR Computational Resource Centre, Singapore 138632, Singapore; [2] Stony Brook University, New York 11794-3600, USA; [3] National Supercomputer Centre in Jinan, Shandong Province, P. R. China

poster at ISC'14, Leipzig, June 2014

InfiniCortex 2014

Legend:
- 10Gbps InfiniBand
- 100Gbps InfiniBand

Locations:
- TITECH (Tokyo)
- Seattle
- GA Tech (Atlanta)
- SC14 (New Orleans)
- A*STAR (Singapore)
- NCI (Canberra)

This is NOT Grid. This is NOT Cloud. This is globally distributed concurrent Galaxy of Supercomputers
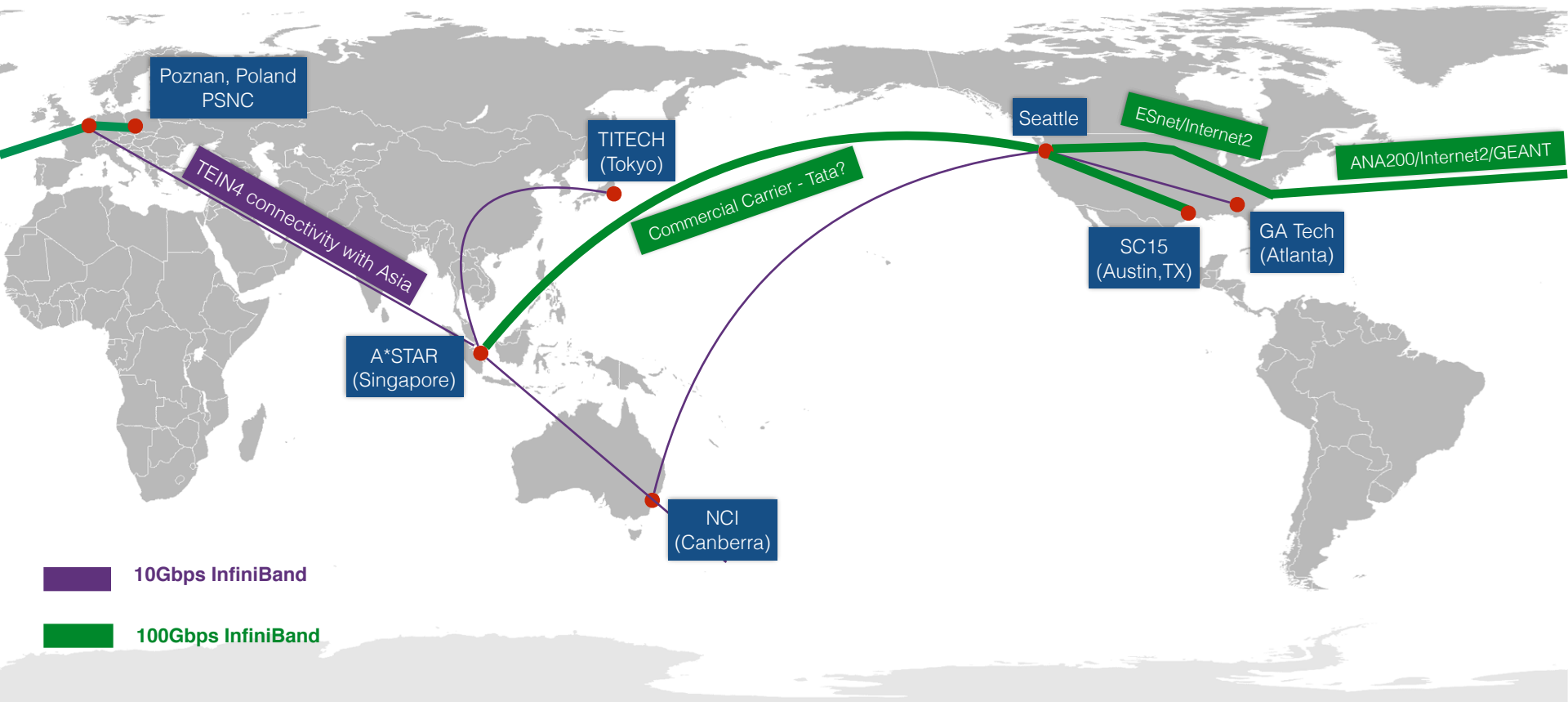
Objective:
To enable a number of geographically dispersed HPC facilities to collaborate and function as ONE concurrent supercomputer, bringing the capability to address and solve grand challenges to the next level of efficiency and scale.

Implications of this demo:
1. soon all hospitals will have sequencers
2. hospitals won't have supercomputers
3. it will be possible to send large patient specific datasets for processing at arbitrary HPC centre
4. HPC Cloud resources will be provisioned instantly
5. results sent to doctor's tablet, at patient's bedside in less than 30 min

Average Time (y-axis: 0h to 14h)

- rsync A*Star to NCI R&E path: **12h 33m**
- rsync A*Star to NCI 10Gbs IPoIB: **9h**
- DSYNC 1Gbs IB path: **4h 5m**
- DSYNC 10Gbs IB path (~26,000Km): **24m**

1,143Gb data set

InfiniCortex 2015

Poznan, Poland
PSNC

TITECH
(Tokyo)

Seattle

ESnet/Internet2

ANA200/Internet2/GEANT

TEIN4 connectivity with Asia

Commercial Carrier - Tata?

SC15
(Austin,TX)

GA Tech
(Atlanta)

A*STAR
(Singapore)

NCI
(Canberra)

10Gbps InfiniBand

100Gbps InfiniBand

2015 Extension of InfiniCortex:
100Gbps InfiniBand East-ward link: Singapore-trans-Pacific-USA-trans-Atlantic-Europe
10Gbps InfiniBand West-ward link: Singapore-Europe (via TEIN4)

InfiniCortex 2015

2015 European Partners:
GEANT, University 1; University 2, Poznan Supercomputing and Networking Centre, Poland; ICM Warsaw, Poland,
(*others (tentative): Frankfurt, Amsterdam, Czech Republic, UK*)

SUPERCOMPUTING FRONTIERS SINGAPORE 2015

17–20 MARCH 2015 | SINGAPORE

Organised by A*STAR Computational Resource Centre, Supercomputing Frontiers 2015 will explore global trends and innovations in high performance computing in convolution of the following important areas:

- Supercomputing applications in domains of critical impact in economic and human terms, and especially those requiring computer resources approaching Exascale;

- Big Data science merging with Supercomputing with associated issues of I/O, high bandwidth networking, storage, workflows and real time processing;

- Architectural complexity of Exascale systems with special focus on supercomputing interconnects, interconnect topologies and routing, and interplay of interconnect topologies with algorithmic communication patterns for both numerically intensive computations and Big Data; and

- Any other topics that push the boundaries of Supercomputing to Exascale and beyond.

EXTRA HIGHLIGHTS:

All-day tour of A*STAR, NTU & NUS research labs on Monday, March 16, 2015
(reservation is essential)

Workshop & Tutorials on Friday, March 20, 2015:
- Energy efficient exascale computing & data centres
- Monte Carlo method
- HPC Big Data Services

Experience some of Singapore's sensational attractions:
- Discover the Night Safari
- Explore the mangroves and bird sanctuary of Sungei Buloh Wetlands Reserve
- Soak up the tropical delights of the Singapore Botanic & Orchid Gardens
- Get a bird's eye view with the Singapore Flyer
- Enjoy the Supertree Grove's light & sound Garden Rhapsody at Gardens By The Bay
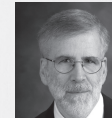
KEYNOTE SPEAKERS:

JACK DONGARRA
University of Tennessee/Oak Ridge National Laboratory, USA

JOHN GUSTAFSON
Ceranovo Inc., USA

ROBERT HARRISON
Brookhaven National Laboratory, USA

WILLIAM HARROD
DOE Office of Advanced Scientific Computing Research, USA

SCOTT KLASKY
Oak Ridge National Laboratory, USA

SATOSHI MATSUOKA
Tokyo Institute of Technology, Japan

THOMAS STERLING
Indiana University, USA

RICK STEVENS
Argonne National Laboratory, USA

CONFIRMED SPEAKERS:

MARK AINSWORTH, Brown University, USA / **PETE BECKMAN,** Argonne National Laboratory, USA / **ULRICH BRÜNING**, University of Heidelberg, Germany / **MICHAEL BUSSMAN**, Helmholtz-Zentrum Dresden-Rossendorf, Germany / **CHOONG-SEOCK CHANG**, Princeton Plasma Physics Laboratory, USA / **HANK CHILDS**, University of Oregon, USA / **BJÖRN GMEINER**, University of Erlangen-Nuremberg, Germany / **DANIEL S. KATZ**, University of Chicago, USA / **JAY LOFSTEAD**, Sandia National Laboratories, USA / **BARNEY MACCABE**, Oak Ridge National Laboratory, USA / **BRUNO MICHEL**, IBM Zurich Reseach Laboratory, Switzerland / **KENNETH MORELAND**, Sandia National Laboratories, USA / **MANISH PARASHAR**, Rutgers, The State University of New Jersey, USA / **THOMAS SCHULTHESS**, ETH Zurich, Switzerland / **JEROEN TROMP**, Princeton University, USA

REGISTRATION NOW OPEN

www.supercomputingfrontiers2015.com

Organised by
Computational Resource Centre
A*STAR

Sponsors:
NANYANG TECHNOLOGICAL UNIVERSITY

NUS
National University of Singapore