SDN-NFV Infrastructure for Disaster Mitigation and Smart Cities

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- Disaster Mitigation
- Visualization with SDN-NFV
- Access Control for SDN-NFV

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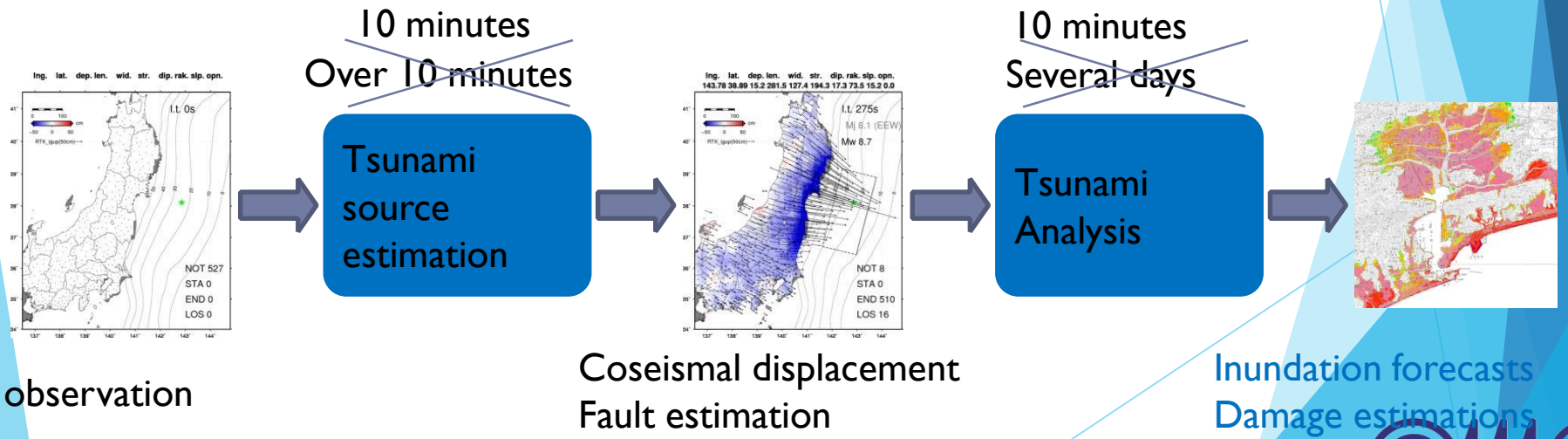
Objective of Real-Time Tsunami Analysis

- Delivery of the inundation forecasts and damage estimations within 20 minutes of an earthquake
  - Tsunami source estimation in 10 minutes
  - Tsunami analysis with 10 m grids in next 10 minutes 10 – 10 – 10 Challenge



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System Configuration

SX-ACE joins the system as soon as a large earthquake (>M7) occurs

Quake Information
GPS Obs. data

Earth quake

RAPiD System

RTK-GPS analysis

Fault model estimation

SX Job submit

JGN-X

SX-ACE

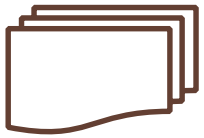
NQSII: Urgency Function

Tsunami Analysis

Tohoku Univ.
Cyberscience Center

Local Government

Delivery Server



Inundation forecasts
Damage estimations

Tohoku Univ.
International Research of Disaster Science

SX-ACE

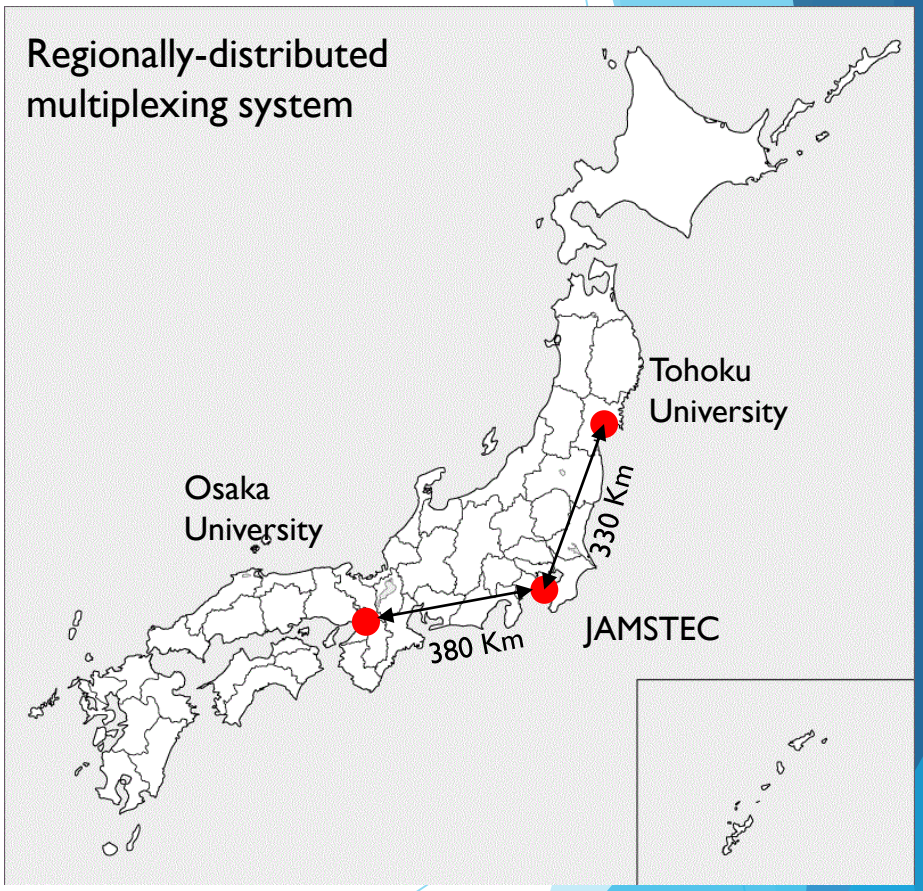
NQSII: Urgency Function

Tsunami Analysis

Osaka Univ.
Cybermedia Center

System Multiplexing

- Handling
  - Tohoku University
    - SX-ACE 2560 nodes
- Cooperate with
  - Osaka University
    - SX-ACE 1536 nodes
  - JAMSTEC
    - SX-ACE 5120 nodes
- Effects
  - Increasing disaster resistance
  - Load distribution
- First experiment
  - Jobs sharing between Sendai and Osaka



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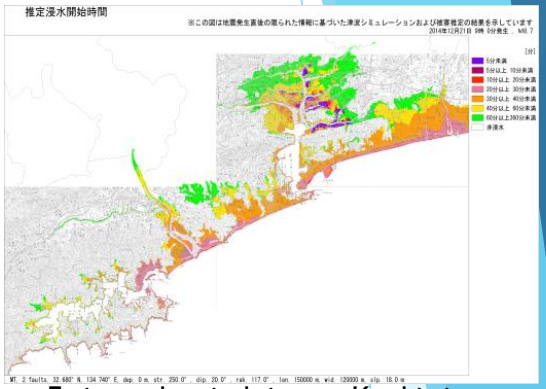
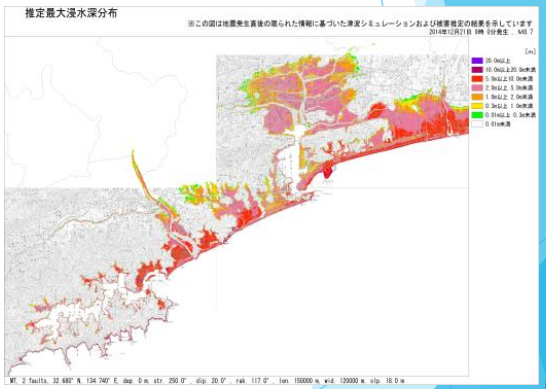
Products of Real-Time Tsunami Analysis

- Tsunami inundation forecasting
  - Tsunami arrival time
  - Tsunami inundation depth
  - Tsunami inundation start time
  - Tsunami level changes
- Damage estimate
  - Day time population
  - Night time population
  - Structural damage (houses)
- The products are delivered to local government



Estimated arrival time at Kochi city



Estimated inundation depth at Kochi city

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G空間シティー構築事業

owl.irides.tohoku.ac.jp/maps/sinsui/201612051133

検索

即時（リアルタイム）津波浸水予測・被害推定結果

データ参照 データDL ユーザー一覧 ログアウト

最大浸水深：各地の津波浸水深の最大値を表示します。
（発生時刻： 2016/12/05-11:33　推定時刻： 2016/12/05-11:33）

到達時間 | 浸水開始時間 | 水位時系列 | 最大浸水深 | 最大水位 | 被害推定

防災拠点 ON/OFF　拠点一覧表示へ

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G空間シティー構築事業

owl.irides.tohoku.ac.jp/maps/saidai_suii/201612051133

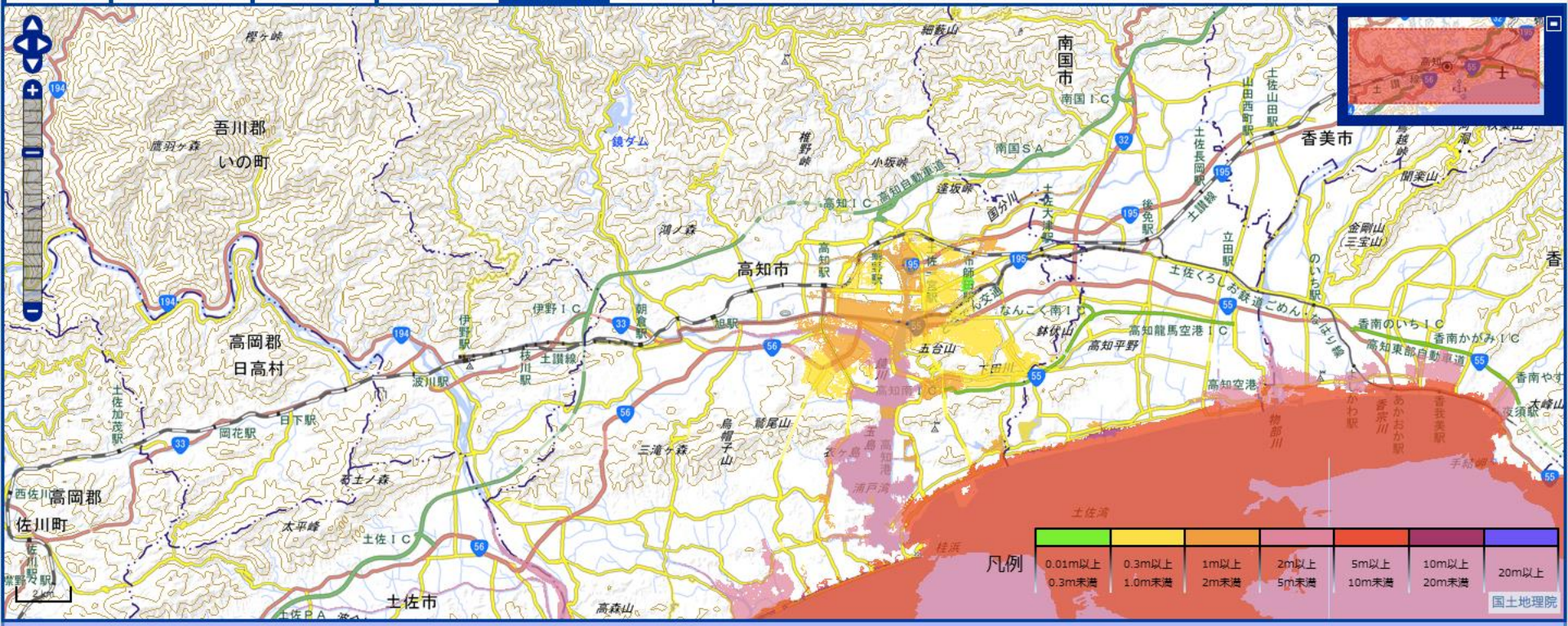
検索

即時（リアルタイム）津波浸水予測・被害推定結果

データ参照 | データDL | ユーザー一覧 | ログアウト

最大水位：津波の最大水位を満潮位からの高さとして表示します。
（発生時刻： 2016/12/05-11:33　推定時刻： 2016/12/05-11:33）

到達時間 | 浸水開始時間 | 水位時系列 | 最大浸水深 | 最大水位 | 被害推定



防災拠点 ON/OFF

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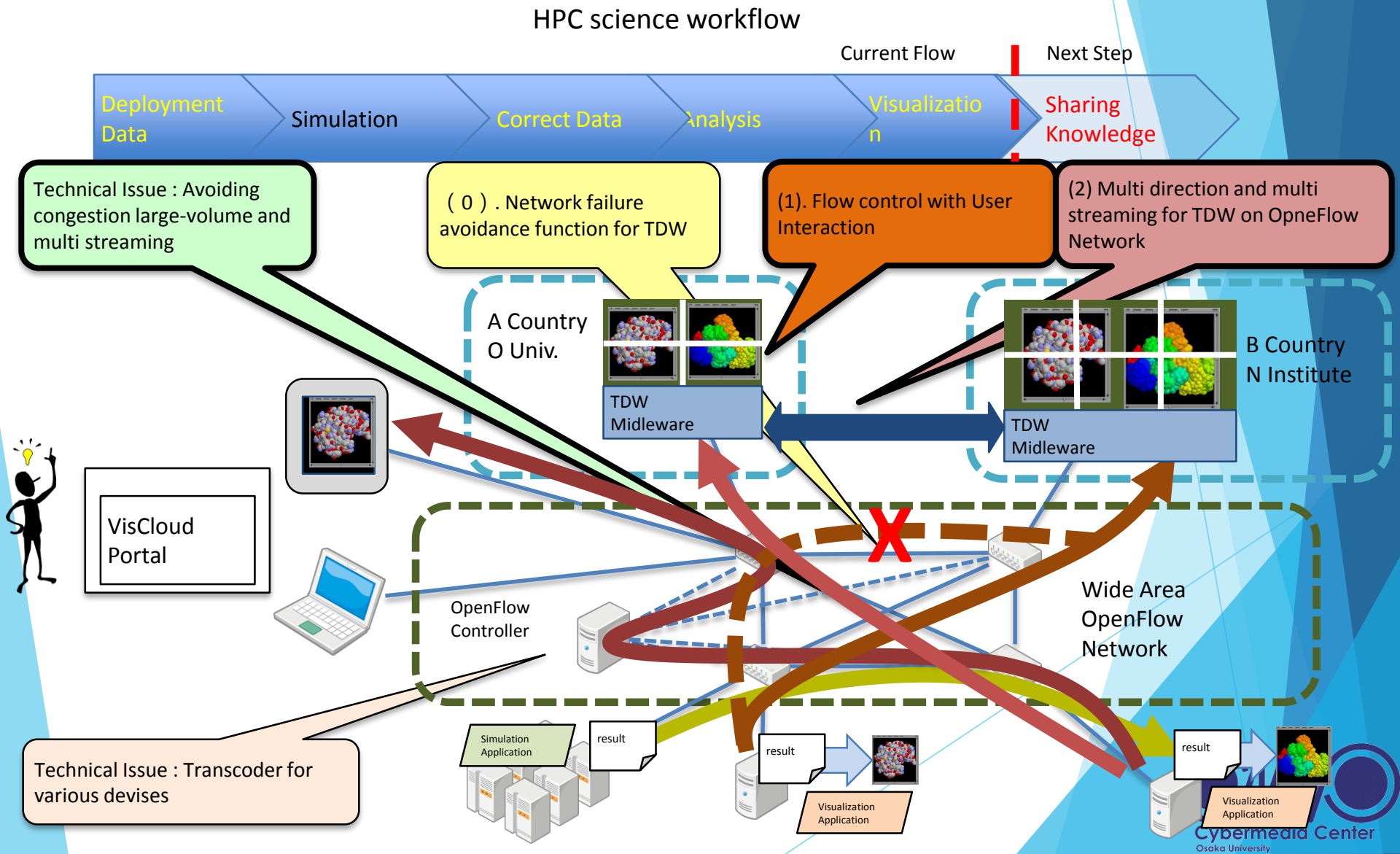
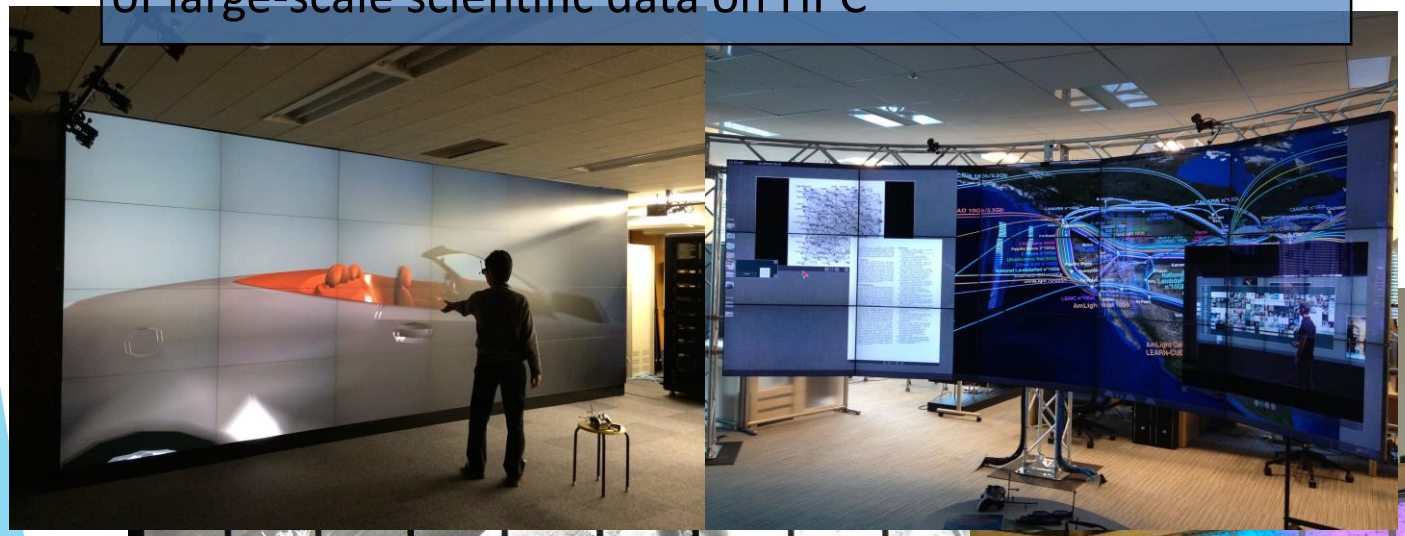
VisCloud : On going and Future Works



Visualization for e-Science : Tiled Display Wall

- **Tiled Display Wall (TDW)**
  - **Ultra high resolution and scalable visualization system**
  - **Sharing environment for large scale visualization contents is needed to e-Science community.**

TDW has been widely accepted and used for visualization of large-scale scientific data on HPC



NCMIR
NATIONAL CENTER for MICROSCOPY and IMAGING RESEARCH
at San Diego, an NIH supported resource center

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[SC12/SC13]Network Failure Avoidance TDW using SDN and Buffering

Issue

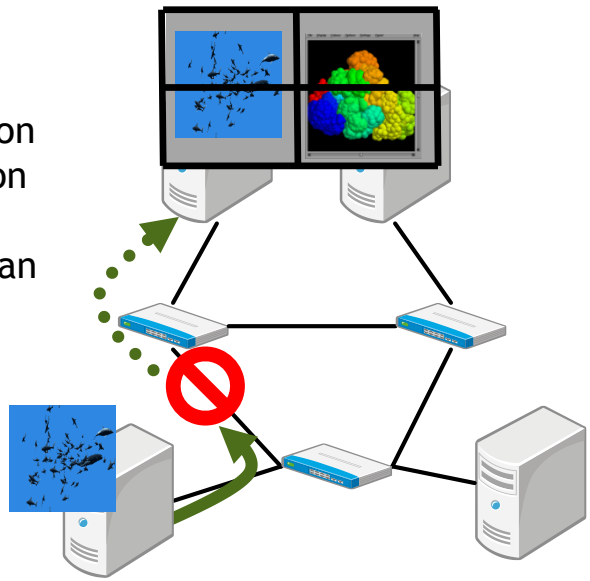
- **SAGE depends heavily on a network streaming technique in its architecture, however does not have any recovery mechanism against cases of network problems**

Result

- **This research aims at realizing a network failure avoidance functionality for SAGE, focusing on OpenFlow against SAGE vulnerability to network failure.**
- *T. Furuichi, S. Date, H. Yamanaka, K. Ichikawa, H. Abe, H. Takemura, and E. Kawai, "A prototype of network failure avoidance functionality for SAGE using OpenFlow", Proceedings of 2012 IEEE 36th International Conference on Computer Software and Applications Workshops, pp.88-93, Jul. 2012.*

Current

A network failure causes disconnection between application server and tiled display. And they can not recover the connection.



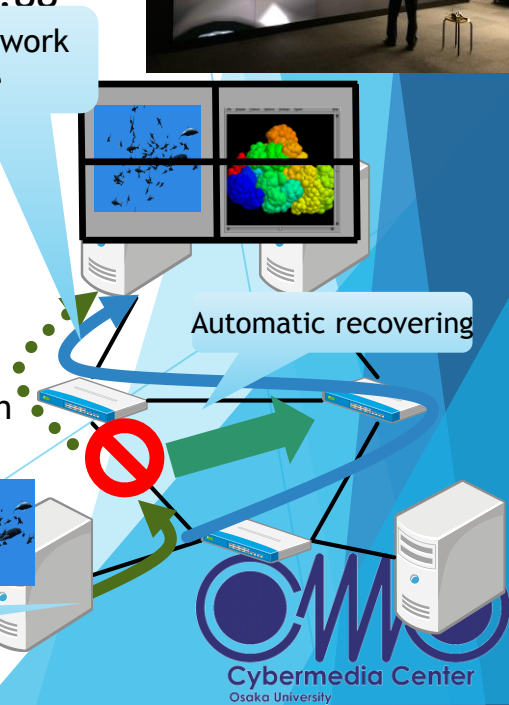
OpenFlow Switch

Propose

If our system meets a network failure, system behaves ;

・Finding another pathway on redundancy network

・Reconnecting between application server and tiled display



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[SC14] SAGE-based Tiled Display Wall Enhanced with Dynamic Routing Functionality Triggered by User Interaction

[Problem]

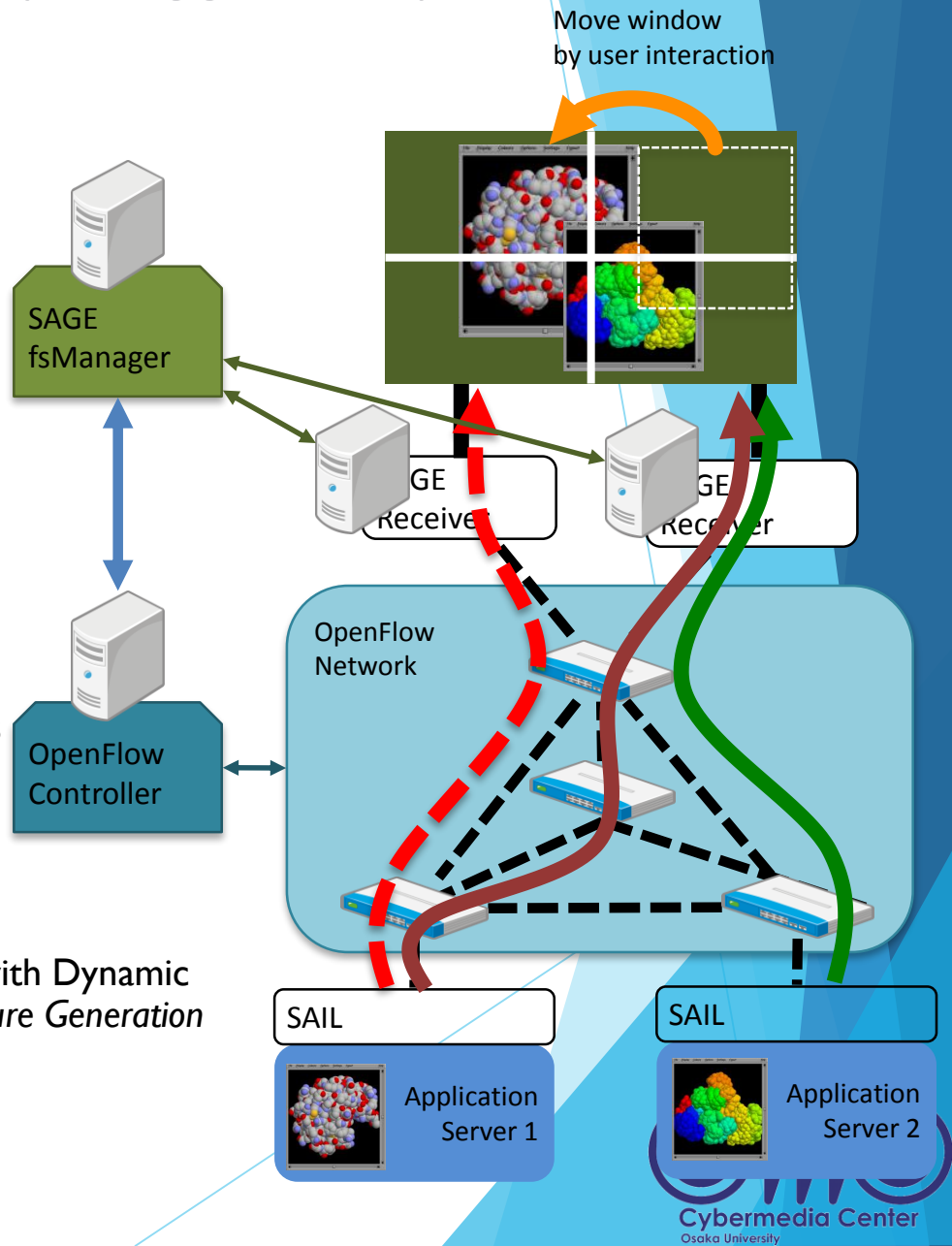
Network congestion causes decreasing visualization quality and frame rate.

[Goal]

Dynamic flow control of multiple network streams from multiple sites for smooth user-interaction & visualization

[Approach]

We modified SAGE with OpenFlow controller as a software program that controls the whole network against network parameters resulted from user interaction.

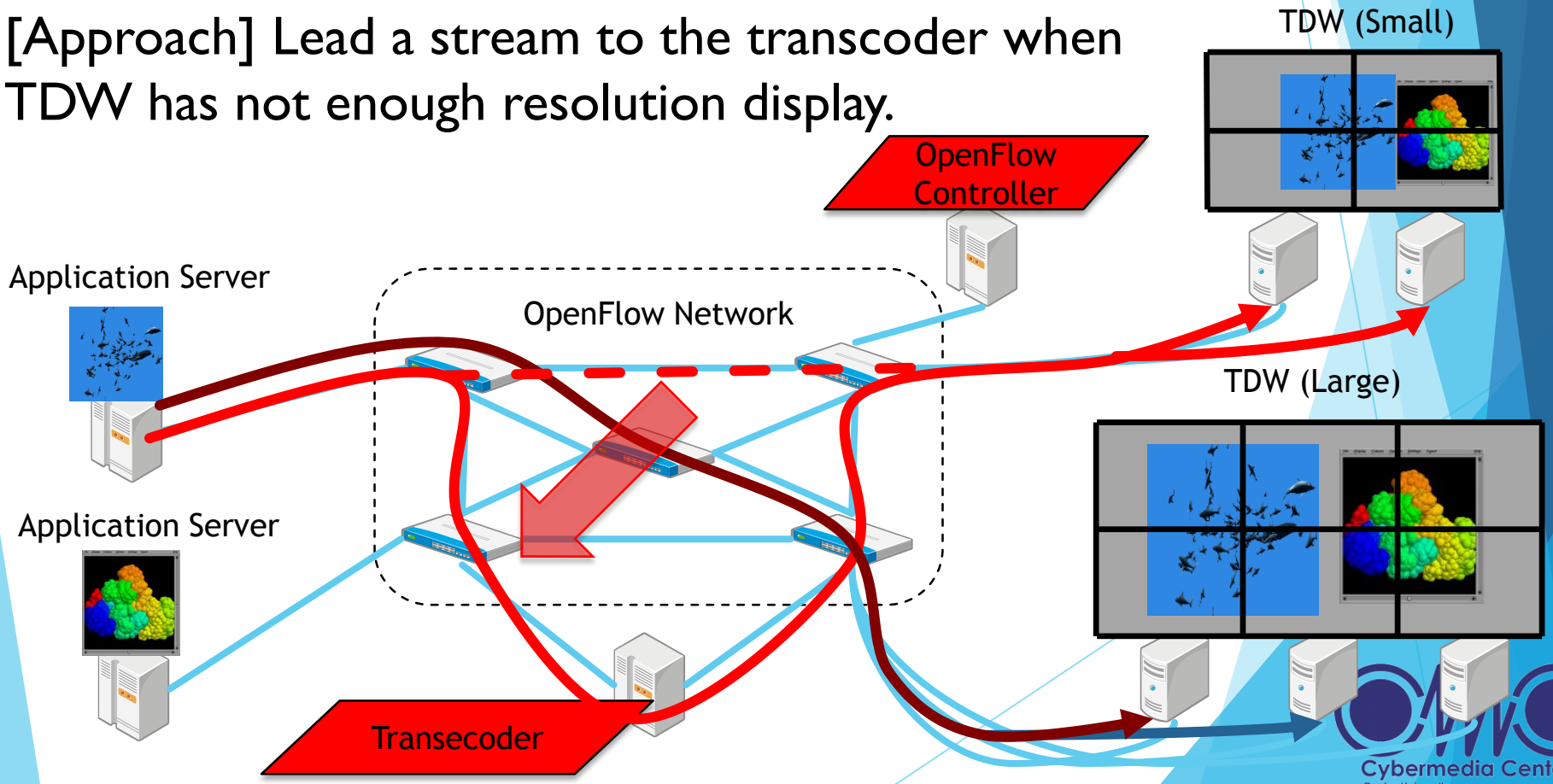


Y.Kido et.al., SAGE-based Tiled Display Wall Enhanced with Dynamic Routing Functionality Triggered by User Interaction, *Future Generation Computer Systems*, Vol. 56, pp.303-314, Mar. 2016

[SC15] Sharing Visualization Contents between TDWs

[Goal] Sharing visualization contents between each different resolution TDW

[Approach] Lead a stream to the transcoder when TDW has not enough resolution display.



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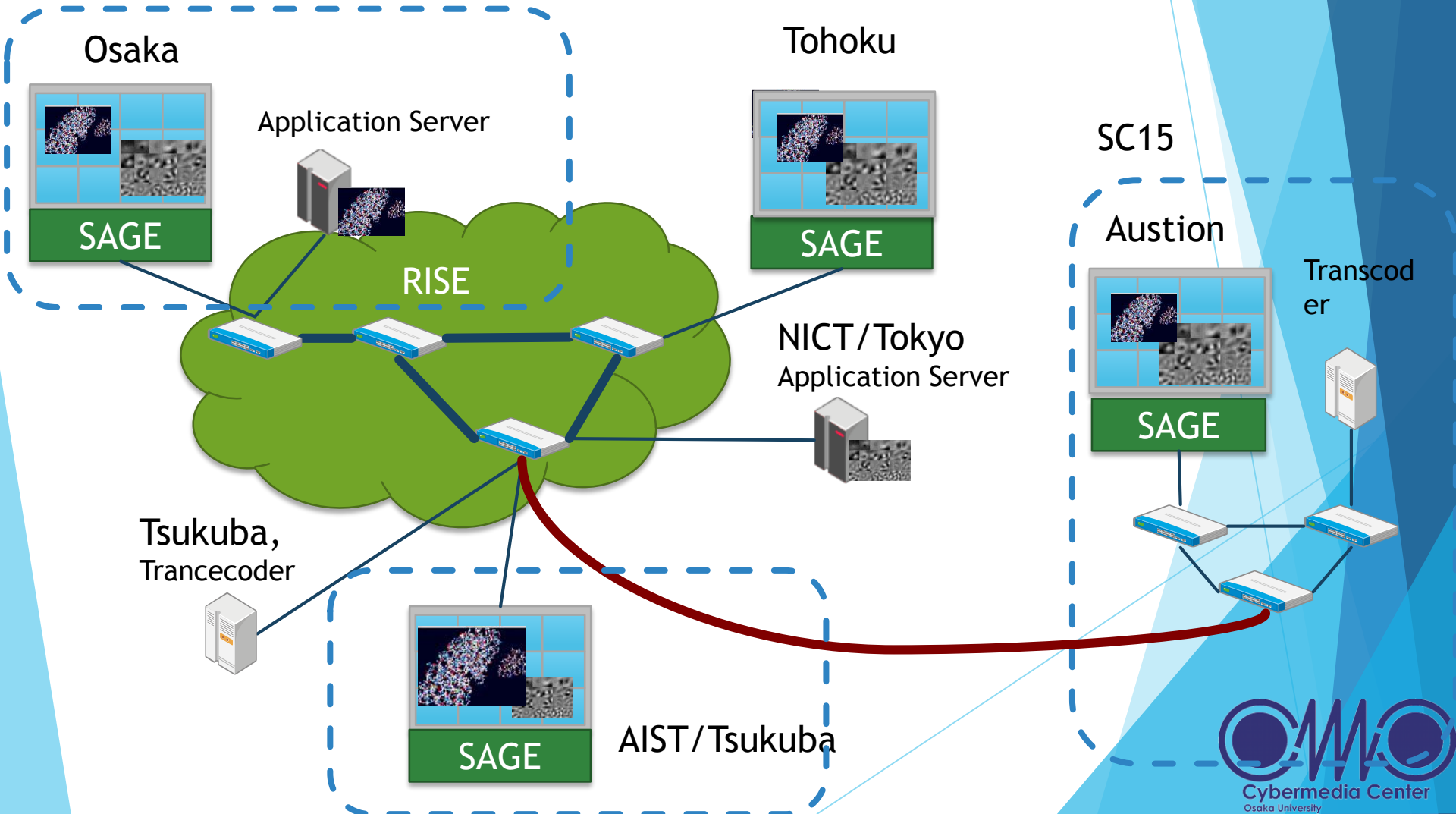
SC15 Demonstration

The environment of Sharing visualization contents between each different resolution TDW



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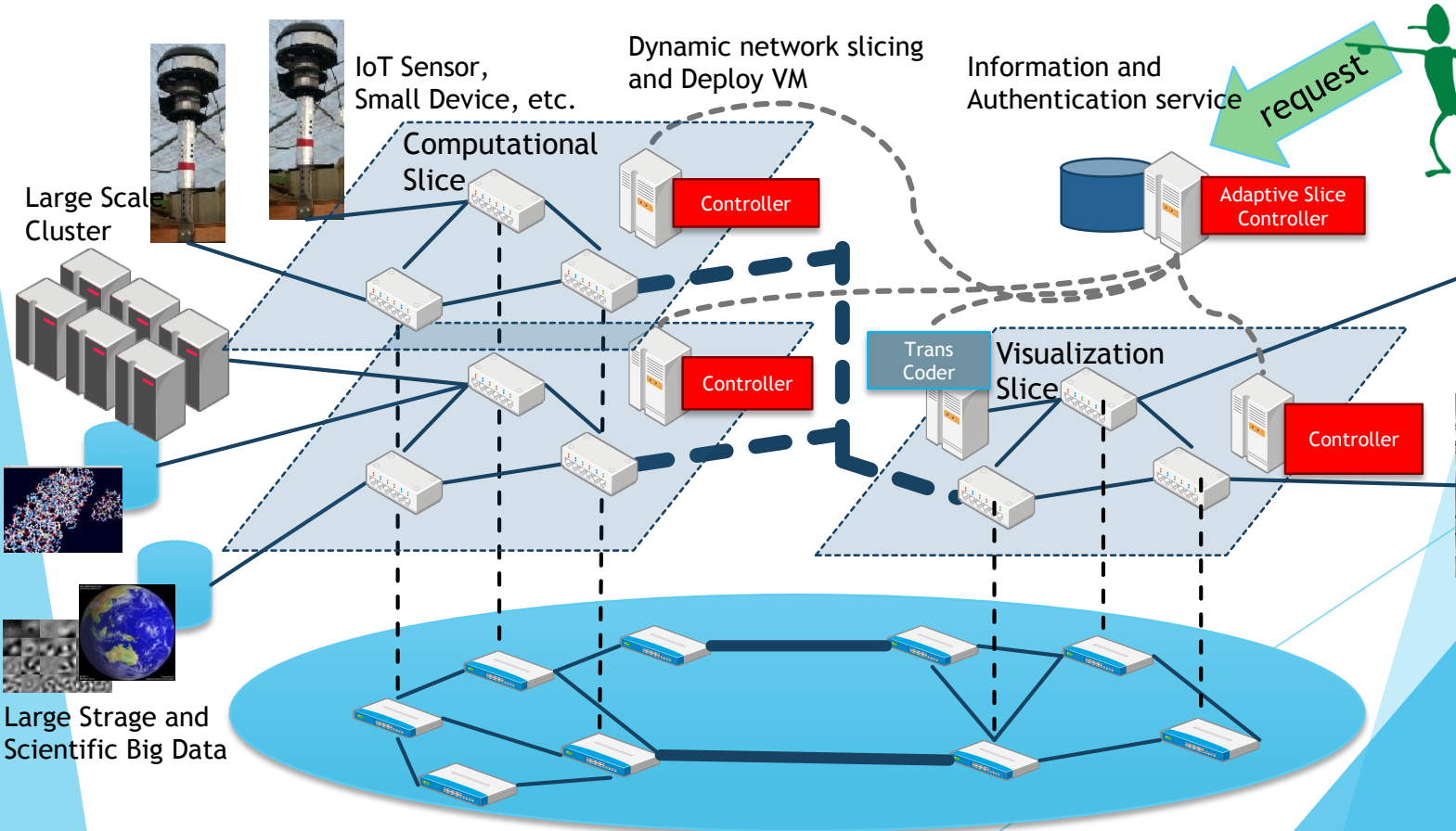
Toward SDN-NFV Infrastructure: Sci-VisCloud

- Sci-VisCloud : an automatically assignment mechanism of network slice with computational resources for each user



大規模可視化装置

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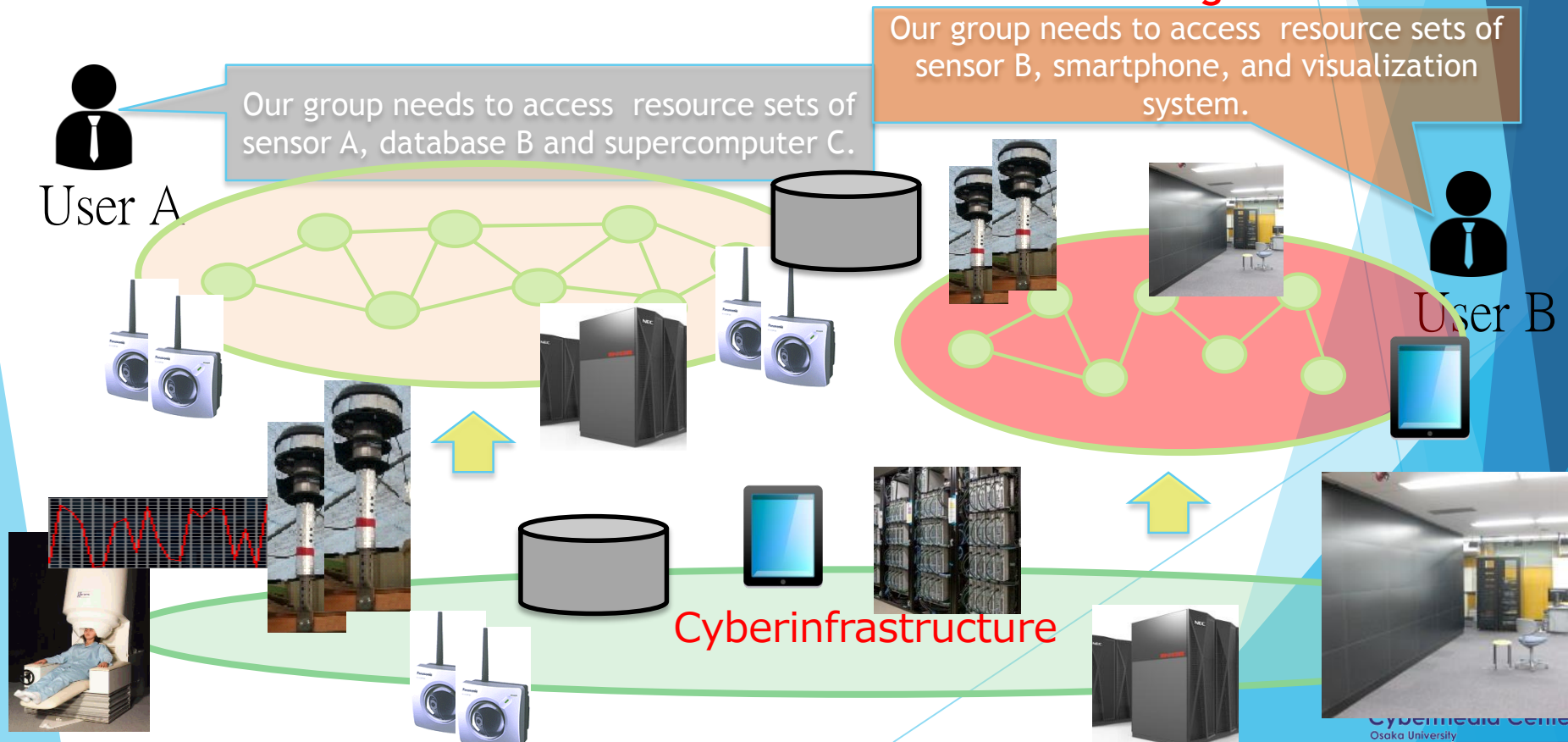
IoT + SDN ?

- What we can change IoT world if we can "program" network?

IoT: a diversity of resources(things) are connected onto a network and each of many parties shares a set of things.

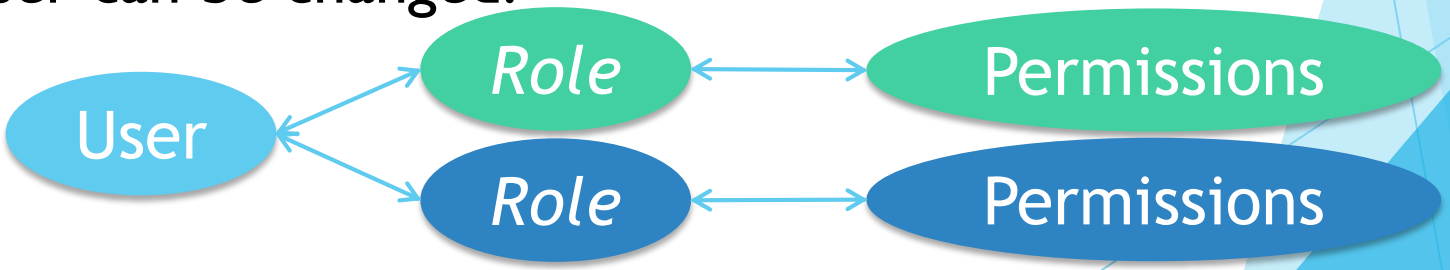
➡ Each party has to be able to access resources, each of which has a different security attributes, with appropriate priviledge.

Problem of Sharing v.s Exclusiveness



Access-controlled networking mechanism

- We propose **an access-controlled networking mechanism** that provides user-dedicated infrastructure.
- We have adopted **RBAC** (Role Based Access Control) and **SDN** (Software Defined Networking) to develop the mechanism.
  - RBAC is a concept of access control that is conducted through *roles*. All users receive permissions only through the *role*. Only changing a role of a user, permissions of the user can be changed.



  - SDN allows us to program and control network resources.

FlowSieve

FlowSieve is a preliminary implementation of the networking mechanism.

- FlowSieve is implemented as **an OpenFlow controller program**.
- FlowSieve has a security policy file that contains
  - Roles information
  - Users information

https://github.com/shimojo-lab/flowsieve/

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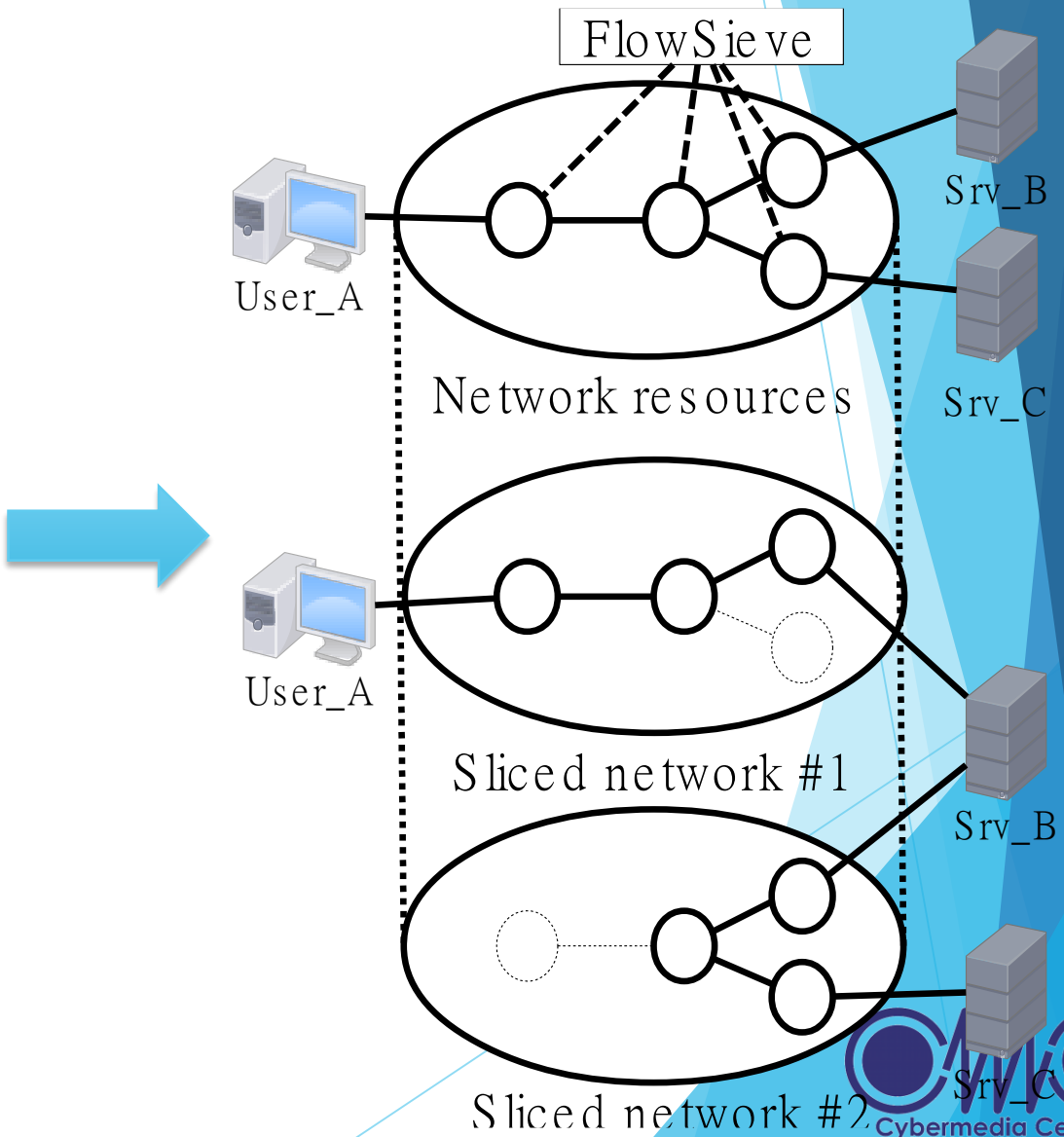
Sliced network by FlowSieve

```
roles:
      - name: A
        allowed_roles:
          - B
      - name: B
        allowed_roles:
          - A
          - C
      - name: C
        allowed_roles:
          - B
users:
      - name: User_A
        role: A
      - name: Srv_B
        role: B
      - name: Srv_C
        role: C
```

Security Policy File



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Summary

- Disaster Mitigation
  - Tohoku Univ. and Osaka Univ. have been constructed a Disaster mitigation system using supercomputer systems.
- Visualization with SDN-NFV
  - We have been developed and modified SAGE with OpenFlow.
  - http://hpc-sdn.ime.cmc.osaka-u.ac.jp
- Access Control for SDN-NFV
  - FlowSieve is a preliminary implementation of the networking and access control mechanism.
  - https://github.com/shimojo-lab/flowsieve/

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