Software Defined System for Disaster Management and Environmental Monitoring

Hiroaki Yamanaka (NICT)
Contents

• Needs for IT-supported solutions in ASEAN region
• Target technologies of research in the ASEAN IVO
• Partner projects
• Platforms for research by NICT
Background

• ASEAN countries
  – Large-scale cities and rural areas severely impacted by disaster or environmental events
  – Disasters often affect or are similar in several countries thus benefitting from collaborative transnational solutions.

• Address issues
  – Understanding phenomena of nature
  – Transnational software-defined cyber infrastructure (CI)
IT-supported solutions

- Environmental monitoring

- Disaster management

- Smart cities
  - To make high QoL and a low-carbon society compatible, we need to expand new lifestyles, culture and art
  - Life services
    - Based on the basic infrastructure and smart infrastructure, we can create new life services for the achievement of high quality of life (QoL) in a low-carbon society
  - Smart infrastructure
    - By adding information communication and sensing functions to the basic infrastructure that supports urban functions, we can improve the information collection and processing capabilities of the infrastructure beyond the conventional level. Moreover, by organically linking individual systems on the platforms, we can provide even more efficient services
  - Basic infrastructure
    - We will develop and improve the basic infrastructure necessary for a disaster-resistant society, including water supply and drainage systems, energy, telecommunications, etc. to meet the needs and constraints of the city
  - Real estate development
    - We will build up the foundation for a desirable city by investigating the local needs and constraints, defining a vision and concepts for the city, and formulating a city plan based on demand forecasts

Software defined systems

• Software definition of system configuration/behavior via management interfaces
  – Computing, networking, storage resources

• Improving performance

• Flexible and easy deployment

Examples:
• Specialized communication protocol
• Application-specific workloads
• Business continuity plan

Partner projects

- Preliminary research activity for international collaboration in ASEAN countries
- Strong leadership of NICT

Center Of Excellence on Enablement of Cyberinfrastructure Applications (housed at NCHC)

East Asia Collaborations to Enable Transnational Cyberinfrastructure Applications (funded by NSF)
US—East Asia Collaborations to Enable Transnational Cyberinfrastructure Applications

- Housed at Advanced Computing and Information Systems Laboratory (ACIS) of University of Florida (UF)

Key goals:

- Scientific advances in
  - Application domains: environmental monitoring (EM), disaster management (DM), smart cities (SC)
  - Software-defined systems: data-sharing, middleware interoperability, coordination
- Creation of next generation of international collaboration networks (of people)
- Creation of a framework for persistent collaboration among centers/groups in US-EA
## CENTRA middleware scope

- Environments and corresponding frameworks and IT stacks that CENTRA research will consider (with examples)

<table>
<thead>
<tr>
<th>Environment</th>
<th>Frameworks</th>
<th>Stacks/platforms</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPC, HTC</td>
<td>Batch scheduling, parallel processing and management, machine learning.</td>
<td>MPI, HTCondor, HDFS, Pegasus, Torque, Lustre, Hadoop, Infiniband</td>
<td>Ocean/lake modeling, MPI applications</td>
</tr>
<tr>
<td>Social nets, ad-hoc systems</td>
<td>Online social networks, overlay networks.</td>
<td>SocialVPN, Jitsi, IPOP</td>
<td>Location-based cooperation</td>
</tr>
<tr>
<td>Big-data stores data management</td>
<td>Distributed unstructured stores, structured databases, index/search systems</td>
<td>Spark, Hadoop, Elastic Search, Riak, Ceph, HBase, PostgreSQL</td>
<td>iDigBio</td>
</tr>
<tr>
<td>Big data, analytics, visualization</td>
<td>Batch and stream processing, machine learning, distributed data processing</td>
<td>OpenStack, Apache Spark Hadoop/YARN.</td>
<td>Lifemapper</td>
</tr>
<tr>
<td>Sensor data processing and communication</td>
<td>Real-time stream processing, data synchronization, compression</td>
<td>Apache Storm, Apache Kafka, Zookeeper, Piax [Yoshida08]</td>
<td>JOSE testbed</td>
</tr>
</tbody>
</table>
Research platforms by NICT

- Research platforms that are possibly utilized for ASEAN IVO research.

<table>
<thead>
<tr>
<th>Platform</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Resilient ICT Research Center</td>
<td>Resilient ICT research collaboration among NICT, Tohoku Univ., and industries</td>
</tr>
<tr>
<td>JOSE</td>
<td>Testbed with a large number of wireless sensors, SDN capabilities and distributed “CLOUD” resources.</td>
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<tr>
<td>RISE</td>
<td>Wide-area SDN testbed, which users can control the networks using their OpenFlow controllers</td>
</tr>
<tr>
<td>PRAGMA-ENT</td>
<td>International collaboration of wide-area network testbeds</td>
</tr>
</tbody>
</table>
Resilient ICT Research Center in NICT

Collaboration among NICT, Tohoku Univ. and Industries

① Robust Photonic Network Platform

② Dependable Wireless & Satellite Network

③ Disaster Information Distribution Platform

Universities and Industries

Test Bed System
Field Experiments of
“Disaster Information Dissemination and Communications”
in SIP (Strategic Innovation Promotion Programs)

Applications

Vertul Network Servers

Association Indoor
Fire Alarms with
Broadcast Messages

Healthcare Assessment
ICT for Refuges

Emergency-mail for
Foreigners and
Handicapped Persons

Quick Network Recovery
in Damaged Areas

Platform @NICT Sendai

Visualize/
Showcases

Experi-
ment DB

Applications
JOSE provides a Japan-wide open testbed, which consists of a large number of wireless sensors, SDN capabilities and distributed “CLOUD” resources. The facilities of JOSE are connected via high-speed network with SDN feature. JOSE will accelerate field trials of “large-scale smart ICT services” essential for building future smart societies.

Provide facilities to verify & evaluate future IoT service technologies by the practical field trials large-scale real environment empowered by “state-of-the-art” SDN technologies.
RISE (Research Infrastructure for Large-Scale Network Experiments)

Wide-area SDN testbed
- East Asia – Japan – US
- Connect to ASEAN countries via TEIN

Connect resources of

- OpenFlow networks with user preferred topologies and VMs are provided.
- Testbed users can control the networks using their own OpenFlow controllers.
PRAGMA-ENT
(Experimental Network Testbed)

• International collaboration of testbeds
• Goals
  – Build a testbed to explore for use by PRAGMA researchers
  – Facilitate collaborations as demonstrated by use of testbed in papers and presentations
PRAGMA-ENT usecase:
Satellite Image Sharing between Taiwan and Japan

• For rapid response to natural disasters, high-speed dedicated network needs to be established in a on-demand manner

Computational Resources

Virtual Network Slice

AutoVFlow

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Initial plan

ASEAN IVO invites researchers to
• help conceptualize international collaborative projects.
• participate in international teams.

Create collaboration research projects launched in near future
Identify participants with same interests in CENTRA and COE
Identify research challenges and requirements for testbeds

International collaboration research in ASEAN countries
Scheduled Meetings

Dec. 7—11 2015
SEIAP 2015, hosted by COE (Taiwan)

Jan. 27—29 2016
PRAGMA/APAN meeting (on 27th Joint Meeting for Disaster Management Workshop)

Feb. 2016 (planned)
ASEAN workshop for Software Defined System for Disaster Management and Environmental Monitoring, hosted by ASEAN IVO (Japan)

Mar. 2016 (planned)
CENTRA Workshop, hosted by CENTRA (US)
### Initial participants for ASEAN IVO (partial)

<table>
<thead>
<tr>
<th>Name</th>
<th>Institute, country</th>
<th>Position</th>
<th>Role in activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lee Bu Sung</td>
<td>SINGAREN, Singapore</td>
<td>Vice President</td>
<td>Software-defined networks</td>
</tr>
<tr>
<td>Hong Hoe ONG</td>
<td>MIMOS, Malaysia</td>
<td>Senior Director</td>
<td>Software-defined systems</td>
</tr>
<tr>
<td>Jing Yuan LUKE</td>
<td>MIMOS, Malaysia</td>
<td>Senior Staff Engineer</td>
<td>Software-defined systems and resilience</td>
</tr>
<tr>
<td>Dr. Kanokvate Tungpimolrut</td>
<td>NECTEC, Thailand</td>
<td>Deputy Director</td>
<td>Disaster management</td>
</tr>
<tr>
<td>Dr. Chalermpol Charnsripinyo</td>
<td>NECTEC, Thailand</td>
<td>Laboratory Director</td>
<td>Software defined IT</td>
</tr>
<tr>
<td>Hiroaki Yamanaka</td>
<td>NICT, Japan</td>
<td>researcher</td>
<td>Software-defined experimental networks</td>
</tr>
<tr>
<td>Shinji Shimojo</td>
<td>NICT, Japan</td>
<td>director of testbed R&amp;D promotion</td>
<td>Software-defined networks and system</td>
</tr>
<tr>
<td>Yasuhiro Murayama</td>
<td>NICT, Japan</td>
<td>Director of Integrated Science Data Research Lab.</td>
<td>Global data sharing</td>
</tr>
<tr>
<td>Hiroshi Kumagai</td>
<td>NICT, Japan</td>
<td>Vice Director of</td>
<td>Resilient ICT research</td>
</tr>
<tr>
<td>Toshiyuki Miyachi</td>
<td>NICT, Japan</td>
<td></td>
<td>Large-scale simulation/emulation environment</td>
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Conclusion

- IVO for transnational research in ASEAN countries
  - Software defines systems
  - Applications: environmental monitoring, disaster management, smart cities
- Partner projects: CENTRA (US), COE (Taiwan)
- Research platforms of NICT possibly utilized for ASEAN IVO
- ASEAN IVO invites researchers for transnational collaboration researches.