ASEAN forum for Software Defined System on Disaster Mitigation and Smart Cities

Background :

With climate change, urbanization and socio-political changes in society, understanding how a disaster event will impact emergency response services remains a challenge, especially in South East Asia countries where natural disasters cause damages economically and casualties. All of these aspects are likely to be disruptive in nature and require decision makers to operate with limited information. Understanding how data can be aggregated in real time to obtain accurate and timely information, and subsequently relaying this to decision makers and victims will provide significant benefits in terms of mitigating the impact of the emergency and providing the basis for social and economic recovery.

Targets:

This project addresses the impact of climate change on cities and urbanization, with particular relevance to the priority area of improving environmental resilience and more specifically in disaster mitigation. This collaboration **proposes a flexible and robust distributed framework for disaster mitigation, crisis communication and emergency management** that can monitor disaster events in near-realtime, based on computational platforms, ranging from automated weather sensors, water gauges, smartphones and laptops, to remote computing and data storage platforms. – the platform would be based on dual-use infrastructure using the latest Software Defined System technologies. The proposed forum will find critical technologies, use cases and develop and deploy collaborative platform in ASEAN region. Use of NICT's existing testbeds such as JGN-X, Starbed and JOSE will have great leverage of research and development. Collaborating with already funded activities in each institution as well as outside projects such as PRAGMA (NSF, US), CENTRA (NSF, US) and CECEA (Taiwan), we can accelerate our activities.

Speaker:

Luke Jing Yuan, MIMOS, Malaysia

ASEAN forum for Software Defined System on Disaster Mitigation and Smart Cities

Project Members :

Name	Position/Degree	Department, Institution, Country
ONG Hong Hoe	Senior Director, PhD	Advanced Computing Lab, MIMOS Berhad, Malaysia
LUKE Jing Yuan	Principal Engineer, B.Eng	
Kanokvate Tungpimolrut	Senior Director, PhD	NECTEC, Thailand
Udom Lewlomphaisarl	PhD	
Chalermpol Charnsripinyo	Senior Research Specialist, PhD	
Myint Myint Sein	Professor/Dean/ PhD	Research and Development Department, GIS Lab, University of Computer Studies, Yangon, Myanmar
KZin Phyo	Assistance Lecturer/Researcher	
Khaing Sue Htet	Lecturer/Researcher	
NGO, Hong Son	Dean, PhD	School of Information and Communication Technology, Hanoi University of Science and Technology, Vietnam
Binh Minh Nguyen	Assistant Professor	
Linh Truong Dieu	Assistant Professor	
DINH, Van Dzung	Deputy Director, PhD	Information Technology Institute, Vietnam National University, Hanoi (VNU), Vietnam
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Alejandro H. Ballado Jr.	Dean, PhD	Mapua University, Philippines
Febus Reidj G. Cruz	Senior Researcher, PhD	
Meo Vincent C. Caya	PHD	
Jocelyn F. Villaverde	Faculty Researcher, PhD	
Glenn V. Magwili	PhD	
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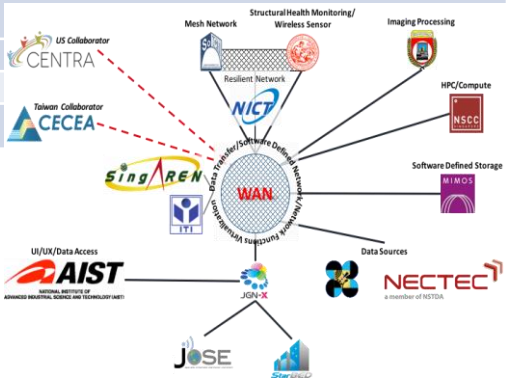
Jay Samuel L. Combinido	Researcher	
John Robert T. Mendoza	Researcher	
Peter Antonio B. Banzon	Chief	
LEE Bu Sung	Treasurer, PhD	SINGAREN, Singapore
Jason Haga	Senior Research Scientist, PhD	AIST, Japan
Hiroaki Yamanaka	Researcher	NICT, Japan

Project Duration :

April 2016 – April 2019



Project Activities:

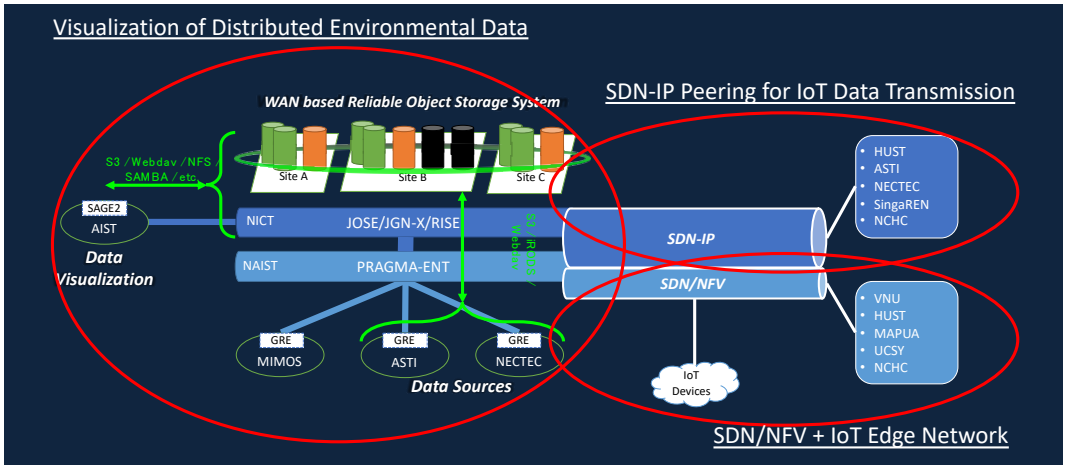
In order to better explore various ideas that may be suitable for the blueprint, 5 project meetings were held between 2016 and 2018 to allow members to discuss these ideas and coordinate the activities or experiments among them. Project members generally utilizes off-the-shelf and open source technologies and solutions in all activities.

The project activities are divided into 3 sub-projects focus on 3 different themes, they are:

A) Visualization of Distributed Environmental Data

B) SDN-IP Peering for IoT Data Transmission

C) SDN/NFV Infrastructure



Project Activities & Results/Conclusions:

A) Visualization of Distributed Environmental Data

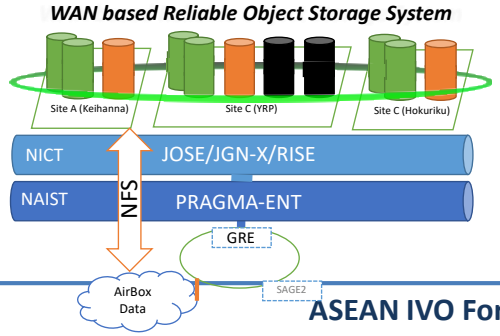
Technologies explored: OpenVSwitch, Ceph, SAGE2, OpenStack

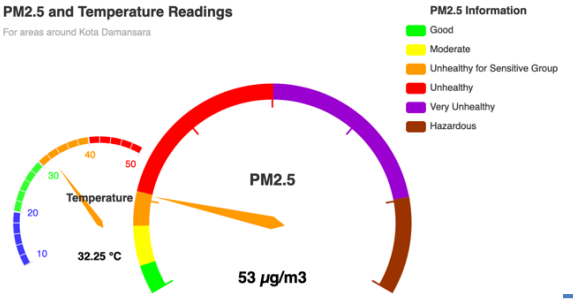
Activity 1: A wide area network software defined storage was setup using JOSE cloud resources from different data centers over JGN-X and using SDN concept via PRAGMA-ENT, a virtual client in MIMOS (Malaysia) access sensor data from internet and then stored the data into this storage using NFS.

Conclusion 1: The testbed behaved as per expectation, challenges in bandwidth and latency are still a concern. Moving forward to design a WAN base storage that encompass ASEAN region and with different data format and sizes as well as exploring data management and analytics in Edge Computing (for example exploring AI platform on-premise or edge as published by MIMOS).

Activity 2: Developing sample code for distributed collaborative visualization using SAGE2. Local SAGE2 environment was setup and tested in MIMOS. AIST team provided a sample code that can be later use to port an existing simple web-based sensor data dashboard to SAGE2 with GIS information added.

Conclusion 2: SAGE2 is a viable platform to share dashboard for different sites such as smart cities' command and control centers. Challenges are in getting the necessary data and developing the applications that reflect those data.





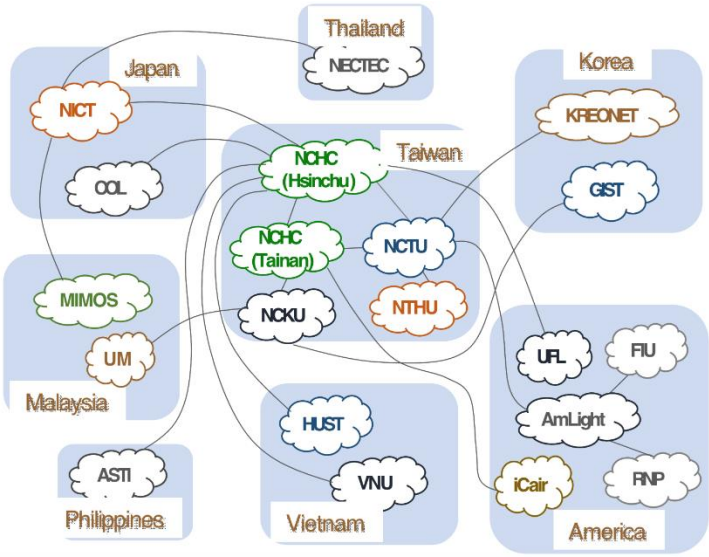
Project Activities & Results/Conclusions:

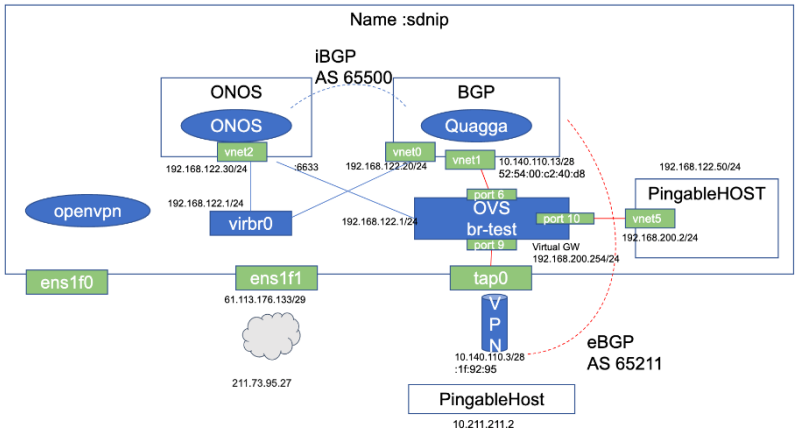
B) SDN-IP Peering for IoT Data Transmission

Technologies explored: OpenVPN, Quagga, ONOS

Activity: This particular activity focuses on experimenting various SDN-IP peering configurations on the said testbed and documenting various challenges of deploying a combination of software-based routing and hardware base systems.

Conclusion: SDN-IP Peering is a viable way to create a software defined network backbone. Current challenges mainly revolve around implementations using both software based and hardware-based solutions as well as documentations on how these challenges can be resolved. Initial documentation was released in second half of 2018 led by researchers from NCHC.





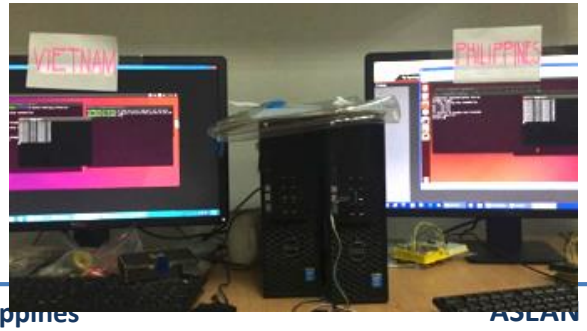
Project Activities and Results/Conclusions:

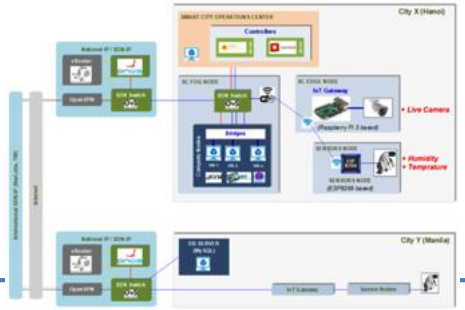
C) SDN/NFV Infrastructure

Technologies explored: OpenDayLight, MQTT, Mininet

Activity: This activity aims to getting all members to familiarize with SDN and NFV technologies. Major effort is devoted to knowledge sharing and training so that all members are capable of building their own local SDN/NFV testbed and value add to the existing tools (for example as published by MAPUA on data transmission between Philippines and Vietnam using OpenDayLight and Mininet). Members in this team are also researching and developing different methods and applications for smart cities (as demoed by VNU during CENTRA3 a simple SDN/NFV concept for street light controller) as well as disaster management (for example emergency vehicle routing published by UCSY)

Conclusion: Edge/IoT devices and applications can leverage on software defined infrastructure such as SDN and NFV for areas like smart cities and disaster mitigation. However, we noticed there is a gap in know-hows and skills among members in SDN and NFV which was addressed with the VNU team providing assistance and guide to other members either using online or offline (during project meeting) methods. In order to further demonstrate this concept, more applications are required such as those taken by the MAPUA and UCSY team members.





Scientific Contributions/Published Papers and Societal Impact:

The Published Papers/Journals:

a) Ismail, Bukhary Ikhwan, et al. "Implementing an On-Premise AI Platform: From DC to Edge", 10th International Conference on Networking and Information Technology, ICNIT, 2019 (MIMOS)
b) Khalid, Mohammad Fairus, et al. "Super-Convergence of Autonomous Things", The 10th International Conference on ICT Convergence (ICCSCE). IEEE, 2019
c) "Comparison of Traditional Network and Software-Defined Network using GNS3 and Mininet", 2018 ICpEP National Convention, 6th National Conference on Computer Applications, Innovations, Technologies and Engineering (CAITE 2018) (MAPUA)
d) Bonifacio, A.C.P., Galo, P.J.C., Lopena, J.M.D., Villaverde, J.F., Magwili, G.V. "Resilient network and data transmission between Philippines and Vietnam via software-defined network using OpenDayLight controller and Mininet", 2018 IEEE 10th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment and Management, HNICEM 2018. (MAPUA)
e) K-zin Phyo and Myint Myint Sein, "Effective Evacuation Route System During Natural Disaster", Asia Pacific Advanced Network Research Workshop (APAN 44), Dalian, China, August 26 – September 1, 2017, pp.70-75. (UCSY)
f) K-zin Phyo and Myint Myint Sein, "Investigation of Optimum Rescue Itinerary by Using Advanced Routing Method", IEEE 7th Global Conference on Consumer Electronics, Nara, Japan, October 4-13, 2018, pp.521-522. (UCSY)
g) "Optimal Route Assessment for Emergency Vehicles Travelling on Complex Road Network", 11th Multi-disciplinary International Workshop on Artificial Intelligence, 2017 (UCSY)
h) "Effective Emergency Response System by Using Improved Dijkstra's Algorithm", 14th International Conference on Computer Applications, ICCA, 2017
i) "Optimal Route Finding for Weak Infrastructure Road Network", Genetic and Evolutionary Computing Proceedings of the Tenth International Conference on Genetic and Evolutionary Computing, 2017 (UCSY)
j) "Quantitative Risk Assessment of Container Based Cloud Platform", AINS 2017 (MIMOS)
k) "CLOF: A proposed Containerized Log management Orchestration Framework", ICOS 2017 (MIMOS)
l) "Reference Architecture for Search Infrastructure", ICCSCE 2017 (MIMOS)
m) "Extending Cloud Resources to the Edge: Possible Scenarios, Challenges and Experiments", ICCCRI, 2016 (MIMOS)
n) "Ext4, XFS, BtrFS and ZFS Linux File Systems on RADOS Block Devices (RBD): I/O Performance, Flexibility and Ease of Use Comparisons", ICOS 2016 (MIMOS)
o) BI Ismail, MF Khalid, OH Hoe, "Policy Management for Docker Ecosystem Managing Edge Computing Devices", The 20th International Computer Science and Engineering Conference 2016 (MIMOS)

Scientific Contributions/Published Papers and Societal Impact:

Presentations at International Conference:

a) "SDN, IoT and Fog Computing testbed for Smart Cities", SEAIP 2018 (VNU)
b) "ASEAN Forum for Software Defined System for Disaster Mitigation and Smart Cities: An ASEAN IVO Project", CENTRA 3, 2018 (MIMOS)
c) "ASEAN Forum for Software Defined System for Disaster Mitigation and Smart Cities", CENTRA 2/PRAGMA 32, 2017 (MIMOS)
d) "ASEAN Forum for Software Defined System for Disaster Mitigation and Smart Cities: An ASEAN IVO Project", SEAIP 2017 (MIMOS)
e) "eResearch Australasia BoF on Transnational Collaborative Research on Smart and Connected Communities", BoF session eResearch Australasia, 2017 (NICT)
f) "ASEAN IVO Project: Software Defined System on Disaster Mitigation and Smart Cities", APAN 42 Future Internet Testbed Working Group, 2016 (AIST)
g) "Visualization of Distributed Environmental Data", CENTRA Webminar, SEAIP 2016 (MIMOS)

Societal Impact:

a) Demo, IoT/NFV/SDN, CENTRA 3, Tokyo, 2018, (VNU)
b) Demo, "Bridging Talents through SAGE2 Collaboration over SDN/IP", SC18, SCinet Network Research Exhibition, USA, 2018 (https://sc18.supercomputing.org/app/uploads/2018/11/SC18-NRE-012.pdf)
c) SDN-IP Installation and Configuration (https://docs.google.com/document/d/14Dg0j9KNAyzTa-WYyubDfr8zUOFq4yyZ8CiCfQMt1jg/edit?usp=sharing)

Conclusions:

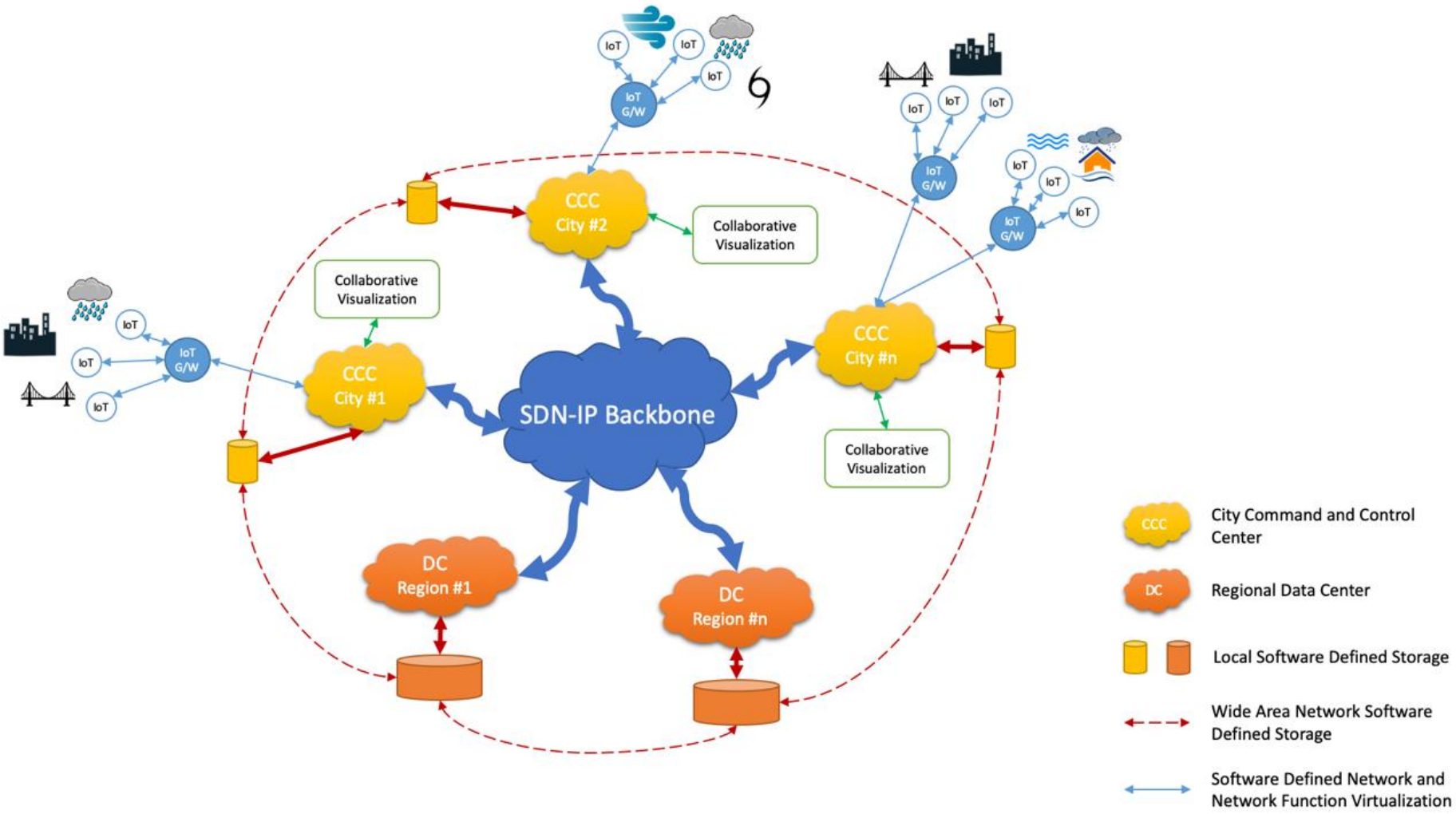
Initial studies indicate that Software Defined Systems can provide potential solutions to setup a resilient infrastructure to support activities in smart cities and disaster management.

As published by MAPUA University, SDN can provide a reliable connectivity for data transmission over 2 countries. With a maturing SDN-IP Peering in progress, it is possible in a foreseeable future that a regional SDN based network infrastructure can provide the necessary resilient infrastructure to support activities for smart cities and disaster management. For example, by using the underlying SDN and coupled with a WAN base Software Defined Storage, critical data such as weather and climate as well as other information for the ASEAN region can be reliably stored and shared in the event if natural disaster disrupts one country's infrastructure.

An important outcome of such resilient infrastructure will be fully explored when more applications such as those researched and developed for route assessment for emergency vehicles, bridge monitoring in smart cities, air quality data and so on can be monitored collaboratively and shared among cities and even countries in ASEAN.

A proposed blueprint for such activities is illustrated in the following diagram:

Conclusions:



Proposed Blueprint for Software Defined System for Smart Cities and Disaster Management

Future prospects:

Further developments can be considered in the following areas:

a) Intelligent Dynamic Routing in SDN-IP Backbone
b) IoT Security
c) Network Function Virtualization for IoT
d) Intelligent Secure Edge Computing Deployment for IoT
e) Applications for emergency management and disaster management
f) Edge Computing and Edge Analytics
g) Actual field work, proof-of-concept, implementing the proposed blueprint