Edge Computing Group

Mission Statement

- This OSF Edge Computing Group's objective is to define infrastructure systems needed to support applications distributed over a broad geographic area, with potentially thousands of sites, located as close as possible to discrete data sources, physical elements or end users. The assumption is that network connectivity is over a WAN.
- The OSF Edge Computing Group will identify use cases, develop requirements, and produce viable architecture options and tests for evaluating new and existing solutions, across different industries and global constituencies, to enable development activities for Open Infrastructure and other Open Source community projects to support edge use cases.

Group Resources

- **Edge Computing Web Page -** https://www.openstack.org/edge-computing/
- **IRC Channel on Freenode - #edge-computing-group**
  - IRC Channel Logs: http://eavesdrop.openstack.org/irclogs/%23edge-computing-group/
- **Mailing list -** http://lists.openstack.org/cgi-bin/mailman/listinfo/edge-computing

Meetings

Weekly calls in alternating slots:

- Tuesdays at 7am PDT / 1500 UTC
- China regional WG calls every Thursday at 0700 UTC

Calendar file is available here [1]**.**

Next meeting: Tuesday (October 15), 7am PST / 1400 UTC

Call details

- **Zoom link:** https://zoom.us/j/879678938
- **Dialing in from phone:**
  - Dial(for higher quality, dial a number based on your current location): US: +1 669 900 6833 or +1 646 876 9923
  - Meeting ID: 879 678 938
  - International numbers available: https://zoom.us/u/ed95sU7aQ

Action item registry

- Greg to put together a short summary of the StarlingX Distributed Cloud feature for the call on October 1st
- Greg to send out a summary mail to openstack-discuss about feedback on Keystone-Kubernetes integration challenges

Agenda

Please feel free to add your topic to the agenda. Please add your name as well so we know on the meeting who to ping.

- Action items
  - See Action item registry
- Work items for testing
  - Detailed design of the minimal reference architectures
  - Configuration of the minimal reference architectures
  - Lab requirements - http://lists.openstack.org/pipermail/edge-computing/2019-June/000597.html
- Hacking days
  - etherpad: https://etherpad.openstack.org/p/osf-edge-hacking-days
  - Every Friday, please add your availability to the etherpad if you're available and interested
- 2nd edge whitepaper
  - https://etherpad.openstack.org/p/osf-ecg-second-whitepaper
- PTG planning
  - https://etherpad.openstack.org/p/PVG-ECG-PTG
  - Schedule: https://www.openstack.org/PTG
- Involving more projects
  - Ironic
    - L3 provisioning and Redfish - http://lists.openstack.org/pipermail/edge-computing/2019-May/000588.html
      - Summit talk: https://www.openstack.org/summit/shanghai-2019/summit-schedule/events/24274/ironically-reeling-in-large-scale-bare-metal-deployment-without-pxe - speakers - Julia Kreger, Ilya Etingof, Richard Pioso
      - L3-based deployment spec update open review - https://review.opendev.org/#/c/672780/
  - Horizon
  - Neutron
    - Segment range improvements? - http://lists.openstack.org/pipermail/edge-computing/2019-May/000589.html
    - Neutron RFE - https://bugs.launchpad.net/bugs/1832526
      - RFE is approved, next steps involve a spec and possibly a PoC
      - PTG session: https://etherpad.openstack.org/p/Shanghai-Neutron-Planning
- Items to keep in mind
  - Keystone edge work
    - StarlingX feedback: http://lists.openstack.org/pipermail/edge-computing/2019-October/000642.html
    - Federation
      - Testing
      - Athenz plugin
        - http://lists.openstack.org/pipermail/edge-computing/2019-January/000520.html

    - StarlingX
        - Synchronization framework
            - Storyboard Story: https://storyboard.openstack.org/#!/story/2002842
    - Glance edge work
        - https://review.openstack.org/#/c/619638/
- AoB

Meeting Logs

https://wiki.openstack.org/wiki/Edge_Computing_Group/Weekly_Call_Logs

Minimal Reference Architectures

https://wiki.openstack.org/wiki/Edge_Computing_Group/Edge_Reference_Architectures

Subgroups

Use cases

- **Liaison: Ildiko Vancsa**
- https://wiki.openstack.org/wiki/Edge_Computing_Group/Use_Cases
- https://etherpad.openstack.org/p/edge-use-case

Meetings

Weekly calls on Mondays in alternating time slots:

- Odd weeks: Monday 1pm Pacific Time / 2000 UTC

Calendar file is available here [2]**.**

Next meeting: Monday (October 7) at 1pm Pacific Time / 2000 UTC

- **Zoom link:** https://zoom.us/j/879678938"'
- Dialing in from phone:
    - Dial(for higher quality, dial a number based on your current location): US: +1 669 900 6833 or +1 646 876 9923
    - Meeting ID: 879 678 938
    - International numbers available: https://zoom.us/u/ed95sU7aQ

Agenda

- Open Infrastructure Summit follow-up
- New use case ideas

Meeting Logs

- 2019
    - September 10: https://zoom.us/recording/share/_Pr_d_77FpD19lgowMmaZU-EJbswiXoRJigGWNhbr_6wIumekTziMw
    - July 29: https://zoom.us/recording/share/JnSXShSR0bDG13M8aWrlCpR_V5iOebpMdD673AVX9OKwIumekTziMw
    - June 17: https://zoom.us/recording/share/ycKWDel5kfZngTn72Fd4rxjtIMys5-NESXZQenxw0Jc

  - June 3: https://zoom.us/recording/share/qy49bd5KXyJDYTtgdieWqkujV0r8VdFjXSYefB8GcDewIumekTziMw
  - May 20: https://zoom.us/recording/share/gWZ9QubJGGZHT6AsyfOOr80bZfe5FDrEUldJevJ6G6OwIumekTziMw
  - April 22: https://zoom.us/recording/share/Mes856E8pjrbE9fJuKpIettfNxDwJQjHRCO8z2h6FRywIumekTziMw
  - April 8: https://zoom.us/recording/share/WMlHTbaQhNz7giVLXB0lGShO7_pQlZo7sK3lVldUYrqwIumekTziMw
  - March 25: https://zoom.us/recording/share/3FQA4pANekiCkemvUmfzWOb4EvrpAHrjFhU16Evy7N-wIumekTziMw
  - March 11: https://zoom.us/recording/play/xMDADfei0TLyfTJanuOy0aSeb0n1dPqTp498Dod5-uS1u9E21UxJrx0-q3DeTtjZ
  - February 25: https://zoom.us/recording/share/757XRwA5SuSSlLdrynjKG7D4HV8-zj0sky10WH-1U42wIumekTziMw
- 2018
  - June 18 - Recording: https://zoom.us/recording/share/kh7kH6QxEfQTQJswKxDNq8b5MccReoZ766g-l71b68ewIumekTziMw
  - June 25 - Recording: https://zoom.us/recording/share/8r2N2XXGbr2-WESGee_l0W0IGihFoF4gpES6iGoimN-wIumekTziMw
  - July 2 - Recording: https://zoom.us/recording/share/eRz-Kvq18s9OTER0JF8OolOhjYhEwTHFmejJbuyvxASwIumekTziMw
  - July 9 - Recording: https://zoom.us/recording/share/TLte9TWWhIKrcAi_hzNNHX_CWuUB66xfohh9Z0yIaYmwIumekTziMw
  - July 23 - Recording: https://zoom.us/recording/share/JzA5Ct0l_fWe4Ae80yOTPwQ1-WPKzdwIhg5sSRIo0_awIumekTziMw
  - August 6 - Recording: https://zoom.us/recording/share/2y4fSaGP0iDRuzA__rHPqTYajGfM5_4taRzf0ANa_piwIumekTziMw
  - September 3 - Recording: https://zoom.us/recording/share/7D4VvnhYtURxVNDa9U2S7CvsbPkweMFbJGDnr9zosJ6wIumekTziMw

Glance

- **Liaison: Gergely Csatari**
- Ongoing activities:
  - There is an experimental API for the multiple backend support. This will be stabilized in Stein.
  - Blueprint [3] for Glance caching enhancements created
- Glance architecture options for edge:
  - https://wiki.openstack.org/wiki/Image_handling_in_edge_environment (UPDATED)
  - Discussion notes:
    - http://eavesdrop.openstack.org/meetings/edge_computing_group/2018/edge_computing_group.2018-08-01-16.01.html
    - https://etherpad.openstack.org/p/EdgeComputingGroupPTG4

Dublin workshop notes

- **Liaison: Gergely Csatari**
- Weekly meetings are on every Thursday from 16h CET on #edge-computing-group
- Notes:
  - https://wiki.openstack.org/wiki/OpenStack_Edge_Discussions_Dublin_PTG
- Meeting notes:
  - http://eavesdrop.openstack.org/meetings/review_of_dublin_edge_notes/2018/
  - http://eavesdrop.openstack.org/meetings/review_of_dublin_edge_notes_ii/2018/review_of_dublin_edge_notes_ii.2018-04-25-14.01.html
  - http://eavesdrop.openstack.org/meetings/review_of_dublin_edge_notes_03/2018/review_of_dublin_edge_notes_03.2018-05-11-13.00.html
  - http://eavesdrop.openstack.org/meetings/review_of_dublin_edge_notes_04/2018/review_of_dublin_edge_notes_04.2018-06-14-14.18.html
- Action items:
  - https://etherpad.openstack.org/p/Dublin-edge-notes-wiki

Keystone

- **Liaison: Ildiko Vancsa**

Artifacts

- Testing plans
  - Keystone edge architectures
    - https://wiki.openstack.org/wiki/Keystone_edge_architectures
    - DevStack Plugin work
      - Test plan etherpad: https://etherpad.openstack.org/p/ECG_Keystone_Testing
      - Spec: https://specs.openstack.org/openstack/keystone-specs/specs/keystone/ongoing/devstack-plugin.html
      - KeystoneDevStackTestingWithInternalIdP
      - Repositories:
        - https://github.com/openstack/keystone-tempest-plugin/
        - https://github.com/wjdanalharthi/tempest/blob/k2k/tempest/api/identity/v3/test_k2k_tokens.py
  - StarlingX DRAFT Design Doc for Distributed DB-Sync'd Keystone Edge Architecture - DRAFT - open to any comments
    - https://www.dropbox.com/s/653tjwnyvl3q544/dc_keystone_fernet_key_sync_and_db_sync_Jul24_2018.pptx?dl=0
  - OPNFV collaboration
    - http://eavesdrop.openstack.org/irclogs/%23openstack-keystone/%23openstack-keystone.2018-05-30.log.html#t2018-05-30T19:09:59
    - https://wiki.opnfv.org/download/attachments/20745096/OPNFV%20Keynotes%20edge%20cloud.pdf?version=1&modificationDate=1528185835342&api=v2
- Vancouver Summit recap from Lance Bragstad: https://www.lbragstad.com/blog/openstack-summit-vancouver-recap
- Vancouver Summit recap from John Garbutt: https://www.stackhpc.com/openstack-forum-vancouver-2018.html

- StarlingX DRAFT Design Doc for Distributed DB-Sync'd Keystone Edge Architecture - DRAFT - open to any comments
  - https://www.dropbox.com/s/653tjwnyvl3q544/dc_keystone_fernet_key_sync_and_db_sync_Jul24_2018.pptx?dl=0

Related OSF Projects

OpenStack

- openstack.org
- IRC channels on Freenode - https://wiki.openstack.org/wiki/IRC
- IRC meetings on Freenode - http://eavesdrop.openstack.org
- Mailing lists - http://lists.openstack.org/cgi-bin/mailman/listinfo

Cyborg

https://wiki.openstack.org/wiki/Cyborg

Glance

- https://docs.openstack.org/glance/latest/
- https://wiki.openstack.org/wiki/Glance

Keystone

- https://docs.openstack.org/keystone/queens/
- https://wiki.openstack.org/wiki/Keystone

Ironic

- https://wiki.openstack.org/wiki/Ironic
- L3 provisioning spec: https://specs.openstack.org/openstack/ironic-specs/specs/not-implemented/L3-based-deployment.html
- HW inventory: https://docs.google.com/document/d/144g8E_fzGD4WZzMvswkeowzcILL4hxg4QDS-46KYCcQ/edit

IoTronic - unofficial

- IoT resource management service for OpenStack clouds
- https://www.openstack.org/assets/presentation-media/vancouver.pdf
  - subproject of Stack4Things: http://stack4things.unime.it
- https://github.com/openstack/iotronic (OpenStack-compliant service for IoT / far-edge nodes IaaS enablement)
- https://github.com/openstack/iotronic-lightning-rod (node-side agent for the IoTronic service)
- https://github.com/openstack/python-iotronicclient (client for the IoTronic service)
- https://github.com/openstack/iotronic-ui (Horizon plugin for the IoTronic service)
- https://bugs.launchpad.net/iotronic/+bugs

Airship

- http://www.airshipit.org
- https://www.openstack.org/videos/vancouver-2018/airship-making-lifecycle-management-for-open-infrastructure-repeatable-and-predictable
- https://github.com/openstack/airship-in-a-bottle
- IRC on Freenode - #airshipit

StarlingX

Liaison: Greg Waines

- http://www.starlingx.io/
- https://www.openstack.org/videos/vancouver-2018/starlingx-cloud-infrastructure-for-high-performance-low-latency-applications
- Distributed Cloud (Incubation Project)
  - https://www.openstack.org/summit/vancouver-2018/summit-schedule/events/21360/edge-computing-operations-day-1-deployment-and-day-2-management
  - https://www.openstack.org/assets/presentation-media/OpenStack-Summit-Edge-Computing-Operations2.pdf
  - Resource Synchronization and Quota Management Framework
    - https://www.dropbox.com/s/ihczi2f5odccn6f/SynchFramework-DC-StarlingX.pptx?dl=0
    - Storyboard Story: https://storyboard.openstack.org/#!/story/2002842
    - Updated Gerrit Code Reviews:
      - https://review.openstack.org/#/c/641471/
      - https://review.openstack.org/#/c/641498/
      - https://review.openstack.org/#/c/641779/
      - https://review.openstack.org/#/c/642113/
      - https://review.openstack.org/#/c/642125/
      - https://review.openstack.org/#/c/642133/
      - https://review.openstack.org/#/c/642469/
      - https://review.openstack.org/#/c/642488/
- mailing list - http://lists.starlingx.io/cgi-bin/mailman/listinfo
- IRC on Freenode - #starlingx

FEMDC SIG

- https://wiki.openstack.org/wiki/Fog_Edge_Massively_Distributed_Clouds

Adjacent communities

Akraino

Liaison: Beth Cohen

- Akraino BoF at the Vancouve Summit - https://etherpad.openstack.org/p/OSS_Vancouver_Akraino_BoF
- Project website - https://www.akraino.org
- Project wiki page - https://wiki.akraino.org

ONAP Edge Automation Group

Liaison: Prakash Ramchandran

- Project wiki page - https://wiki.onap.org/display/DW/Edge+Automation+through+ONAP

OPNFV Edge Cloud Project

Liaison: Gergely Csatari

- Project wiki page - https://wiki.opnfv.org/display/PROJ/Edge+cloud
- Tests draft - https://etherpad.opnfv.org/p/edge_cloud_test_case

Kubernetes IoT Edge Working Group

- Project page: https://github.com/kubernetes/community/tree/master/wg-iot-edge
- Meetings: Fridays at 15:00 UTC (bi-weekly)
- Meeting notes and agenda [4]
- Whitepaper [5]

ETSI MEC

- Web page: https://www.etsi.org/technologies/multi-access-edge-computing
- Presentation on the weekly call (February 12, 2019): https://zoom.us/recording/share/dnRWoPhLvMJz1QUvsjMV7COhydppAwtc3J8w2q08VqmwIumekTziMw
- MEC PoCs
  - https://www.etsi.org/technologies/multi-access-edge-computing/mec-poc
  - https://mecwiki.etsi.org/index.php?title=Ongoing_PoCs
- OpenAPI
  - https://forge.etsi.org
  - Viewable without an EOL account
  - If you would like to propose a patch and you don't have an account please reach out to one of the following contacts
    - CTI_Support - CTI_Support@etsi.org
    - Walter Featherstone_Internet - Walter.Featherstone@viavisolutions.com
  - Bug tracker: https://forge.etsi.org/bugzilla
- Contact: Dario Sabella - dario.sabella@intel.com

Discovery Initiative

Liaison: Adrien Lebre

- Web page: https://beyondtheclouds.github.io/
- Contact: discovery-contact@inria.fr

Use Cases

For specific case studies, see https://wiki.openstack.org/wiki/Edge_Computing_Group/Use_Cases

Data Collection and Analytics

IoT, where data is often collected from a large network of microsites, is an example of an application that benefits from the edge computing model. Sending masses of data over often limited network connections to an analytics engine located in a centralized data center is counterproductive; it may not be responsive enough, could contribute to

excessive latency, and wastes precious bandwidth. Since edge devices can also produce terabytes of data, taking the analytics closer to the source of the data on the edge can be more cost-effective by analyzing data near the source and only sending small batches of condensed information back to the centralized systems. There is a tradeoff here—balancing the cost of transporting data to the core against losing some information.

Security

Unfortunately, as edge devices proliferate—including mobile handsets and IoT sensors—new attack vectors are emerging that take advantage of the proliferation of endpoints. Edge computing offers the ability to move security elements closer to the originating source of attack, enables higher performance security applications, and increases the number of layers that help defend the core against breaches and risk.

Compliance Requirements

Compliance covers a broad range of requirements, ranging from geofencing, data sovereignty, and copyright enforcement. Restricting access to data based on geography and political boundaries, limiting data streams depending on copyright limitations, and storing data in places with specific regulations are all achievable and enforceable with edge computing infrastructure.

Network Function Virtualization (NFV)

Network Function Virtualization (NFV) is at its heart the quintessential edge computing application because it provides infrastructure functionality. Telecom operators are looking to transform their service delivery models by running virtual network functions as part of, or layered on top of, an edge computing infrastructure. To maximize efficiency and minimize cost/complexity, running NFV on edge computing infrastructure makes sense.

Real-Time

Real-time applications, such as AR/VR, connected cars, telemedicine, tactile internet Industry 4.0 and smart cities, are unable to tolerate more than a few milliseconds of latency and can be extremely sensitive to jitter, or latency variation. As an example, connected cars will require low latency and high bandwidth, and depend on computation and content caching near the user, making edge capacity a necessity. In many scenarios, particularly where closed-loop automation is used to maintain high availability, response times in tens of milliseconds are needed, and cannot be met without edge computing infrastructure.

- Monasca Smart City [6]
- Connected Cars / Drones [7]

Immersive

Edge computing expands bandwidth capabilities, unlocking the potential of new immersive applications. Some of these include AR/VR, 4K video, and 360° imaging for verticals like healthcare. Caching and optimizing content at the edge is already becoming a necessity since protocols like TCP don’t respond well to sudden changes in radio network traffic. Edge computing infrastructure, tied into real-time access to radio/network information can reduce stalls and delays in video by up to 20% during peak viewing hours, and can also vary the video feed bitrate based on radio conditions.

Network Efficiency

Many applications are not sensitive to latency and do not require large amounts of nearby compute or storage capacity, so they could theoretically run in a centralized cloud, but the bandwidth requirements and/or compute requirements may still make edge computing a more efficient approach. Some of these workloads are common today, including video surveillance and IoT gateways, while others, including facial recognition and vehicle number plate recognition, are emerging capabilities. With many of these, the edge computing infrastructure not only reduces bandwidth requirements, but can also provide a platform for functions that enable the value of the application—for example, video surveillance motion detection and threat recognition. In many of these applications, 90% of the data is routine and irrelevant, so sending it to a centralized cloud is prohibitively expensive and wasteful of often scarce network bandwidth. It makes more sense to sort the data at the edge for anomalies and changes, and only report on the actionable data.

- Telexistence Robot, SDN and OpenStack [8]

Self-Contained and Autonomous Site Operations

Many environments, even today, have limited, unreliable or unpredictable connectivity. These could include transportation (planes, buses, ships), mining operations (oil rigs, pipelines, mines), power infrastructure (wind farms, solar power plants), and even environments that should typically have good connectivity, like stores. Edge computing neatly supports such environments by allowing sites to remain semi-autonomous and functional when needed or when the network connectivity is not available. The best example of this approach is the need for retail locations to maintain their point of sales (POS) systems, even when there is temporarily no network connectivity.

- Cloud-in-a-box at Verizon [9]

Privacy

Enterprises may have needs for edge computing capacity depending on workloads, connectivity limits and privacy. For example, medical applications that need to anonymize personal health information (PHI) before sending it to the cloud could do this utilizing edge computing infrastructure. Another way to look at requirements that would benefit from cloud edge computing is by the type of company that would deploy them. Operator applications are workloads put on edge computing infrastructure that is built and managed by operators—telecommunications companies, for example. Third-party applications are built by organizations to run on existing edge infrastructure, in order to leverage others' edge computing infrastructure. It is worth noting that any applications could leverage any or all of the capabilities provided by a cloud—compute, block storage, object storage, virtual networking, bare metal, or containers.

Challenges

- **Life-cycle Management.** A virtual-machine/container/bare-metal manager in charge of managing machine/container lifecycle (configuration, scheduling, deployment, suspend/resume, and shutdown). (Current Projects: TK)
- **Image Management.** An image manager in charge of template files (a.k.a. virtual-machine/container images). (Current Projects: TK)
- **Network Management.** A network manager in charge of providing connectivity to the infrastructure: virtual networks and external access for users. (Current Projects: TK)
- **Storage Management.** A storage manager, providing storage services to edge applications. (Current Projects: TK)
- **Administrative.** Administrative tools, providing user interfaces to operate and use the dispersed infrastructure. (Current Projects: TK)

- **Storage latency.** Addressing storage latency over WAN connections.
- **Reinforced security at the edge.** Monitoring the physical and application integrity of each site, with the ability to autonomously enable corrective actions when necessary.
- **Resource utilization monitoring.** Monitor resource utilization across all nodes simultaneously.
- **Orchestration tools.** Manage and coordinate many edge sites and workloads, potentially leading toward a peering control plane or "selforganizing edge."
- **Federation of edge platforms orchestration (or cloud-of-clouds).** Must be explored and introduced to the IaaS core services.
- **Automated edge commission/decommission operations.** Includes initial software deployment and upgrades of the resource management system's components.
- **Automated data and workload relocations.** Load balancing across geographically distributed hardware.
- **Synchronization of abstract state propagation** Needed at the "core" of the infrastructure to cope with discontinuous network links.
- **Network partitioning with limited connectivity** New ways to deal with network partitioning issues due to limited connectivity—coping with short disconnections and long disconnections alike.
- **Manage application latency requirements.** The definition of advanced placement constraints in order to cope with latency requirements of application components.
- **Application provisioning and scheduling.** In order to satisfy placement requirements (initial placement).
- **Data and workload relocations.** According to internal/external events (mobility use-cases, failures, performance considerations, and so forth).
- **Integration location awareness.** Not all edge deployments will require the same application at the same moment. Location and demand awareness are a likely need.
- **Dynamic rebalancing of resources from remote sites.** Discrete hardware with limited resources and limited ability to expand at the remote site needs to be taken into consideration when designing both the overall architecture at the macro level and the administrative tools. The concept of being able to grab remote resources on demand from other sites, either neighbors over a mesh network or from core elements in a hierarchical network, means that fluctuations in local demand can be met without inefficiency in hardware deployments.

References

[1] https://www.openstack.org/assets/edge/OSF-Edge-Computing-Group-Weekly-Calls.ics
[2] https://www.openstack.org/assets/edge/OSF-Edge-WG-Use-Cases-Weekly-Calls.ics
[3] https://blueprints.launchpad.net/glance/+spec/glance-caching-for-edge
[4] https://docs.google.com/document/d/1Yuwy9IO4X6XKq2wLW0pVZn5yHQxlyK7wdYBZBXRWiKI/edit?usp=sharing
[5] https://docs.google.com/document/d/1We-pRDV9LDFo-vd9DURCPC5-Bum2FvjHUGZ1tacGmk8/edit#heading=h.n4tqqt3iuizs
[6] https://www.youtube.com/watch?v=fUz-yIoSIgU
[7] https://www.youtube.com/watch?v=g9TH_6XJWqw
[8] https://www.youtube.com/watch?v=vnYwniyB2b0
[9] https://www.youtube.com/watch?v=WbeLMhcrkz8&t=11s

Article Sources and Contributors

Edge Computing Group *Source*: https://wiki.openstack.org/w/index.php?oldid=172723 *Contributors*: Alan Meadows, Bfcohen, Davpat2112, Gergely.csatari, Gmerlino, Greg-waines, Ildiko, Javier.rojas-balderrama, Jess.lampe, Mbuil

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