

# Fog Computing Surveys and Similar Concepts

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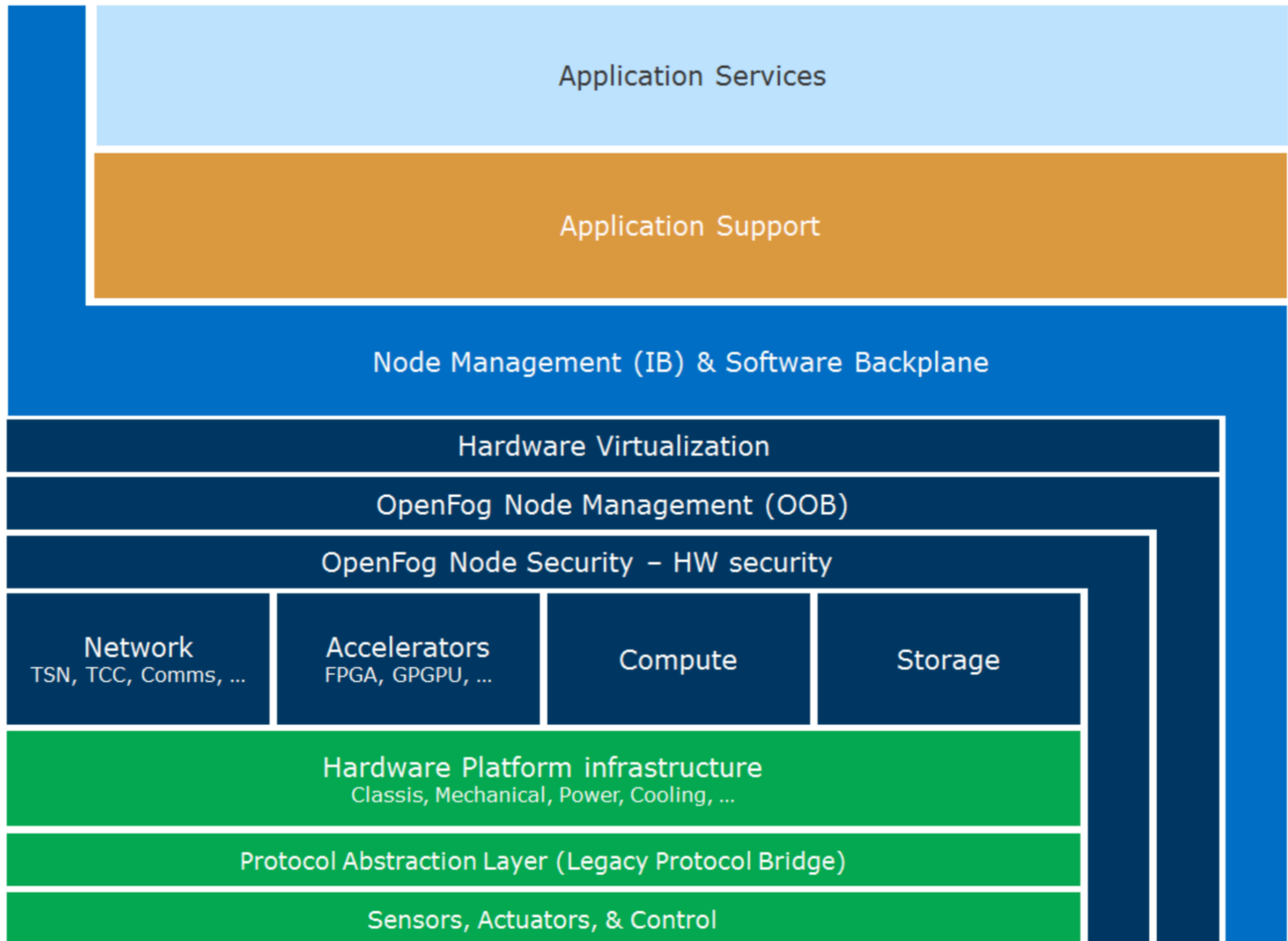
# Definition of Fog Computing

- Cisco [1]: *a cloud close to the ground* (2012)
  - Fog computing is a highly virtualized platform that provides compute, storage, and networking services between end devices and traditional cloud computing data centers, typically, but not exclusively located at the edge of network
- OpenFog [2]: *a link in the cloud-to-things continuum* (2015)
  - Fog computing is a system-level horizontal architecture that distributes resources and services of computing, storage, control and networking anywhere along the continuum from cloud to things

[1] F. Bonomi, R. Milito, J. Zhu, and S. Addepalli. 2012. Fog Computing and Its Role in the Internet of Things. In Proc. of ACM SIGCOMM workshop on Mobile Cloud Computing (MCC). Helsinki, Finland.

[2] OpenFog, <https://www.openfogconsortium.org>

# Architecture of Cloud-to-Things Continuum Platforms<sup>[1]</sup>



# Comparisons of Cloud, Distributed Cloud, CloudLet, and Fog

	High Heterogeneity	Low Latency	Mobility Support	Location Awareness	Virtualization Support
Cloud	×	×	×	×	✓
Distributed Cloud [4]	×	△	△	△	✓
Cyber Foraging [5]	△	✓	✓	✓	×
CloudLet [3]	△	✓	✓	✓	✓
MEC [1]	△	✓	✓	✓	✓
Fog [2]	✓	✓	✓	✓	✓

[1] C. Mouradian, D. Naboulsi, S. Yangui, R. Glitho, M. Morrow, and P. Polakos, “A Comprehensive Survey on Fog Computing: State-of-the-art and Research Challenges,” *IEEE Communications Surveys & Tutorials*, 20(1), 416-464, 2017.

[2] F. Bonomi, R. Milito, J. Zhu, and S. Addepalli, “Fog Computing and Its Role in the Internet of Things” in *Proc. of ACM SIGCOMM workshop on Mobile Cloud Computing (MCC)*, Helsinki, Finland, 2012.

[3] M. Satyanarayanan, V. Bahl, R. Caceres, and N. Davies, “The Case for VM-based Cloudlets in Mobile Computing.” *IEEE pervasive Computing*, 8(4), 14-23, 2009.

[4] P. Endo, A. de Almeida Palhares, N. Pereira, G. Goncalves, D. Sadok, J. Kelner, B. Melander, and J. Mangs, “Resource Allocation for Distributed Cloud: Concepts and Research Challenges,” *IEEE Network*, 25(4), 42-46, 2011.

[5] R. Balan, J. Flinn, M. Satyanarayanan, S. Sinnamohideen, and H.-I. Yang, “The case for cyber foraging,” in *Proc. 10th Workshop ACM SIGOPS Eur. Workshop*, Saint-Émilion, France, 2002, pp. 87–92.

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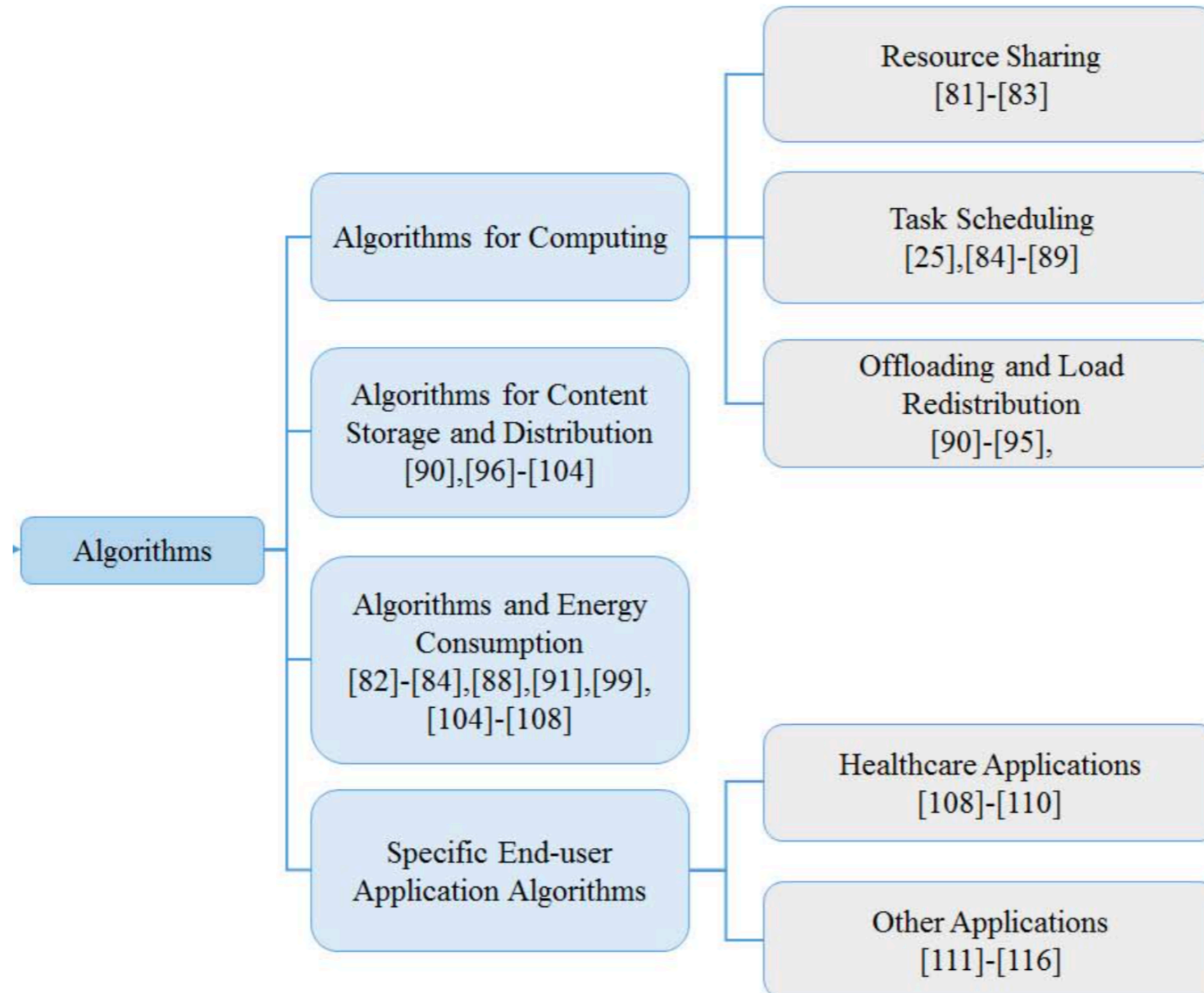
# Fog Computing Surveys

Year	Authors	Journal/Conferences	Main Focuses
2015	Shanhe et al.	Mobidata	Similar Concepts and Fog Issues
2017	Mouradian et al.	IEEE Communications Surveys & Tutorials	Algorithms
2017	Charith et al.	ACM Computing Surveys	Functionalities of Ideal Fog Platform
2017	Jianbing et al.	IEEE Communications Surveys & Tutorials	Security
2017	Mithun et al.	IEEE Access	Security and Privacy
2018	Mithun et al.	IEEE Communications Surveys & Tutorials	Network
2018	Redowan et al.	Springer	Taxonomy by challenges

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# A Comprehensive Survey on Fog Computing: State-of-the-Art and Research Challenges



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# Fog Computing for Sustainable Smart Cities: A Survey

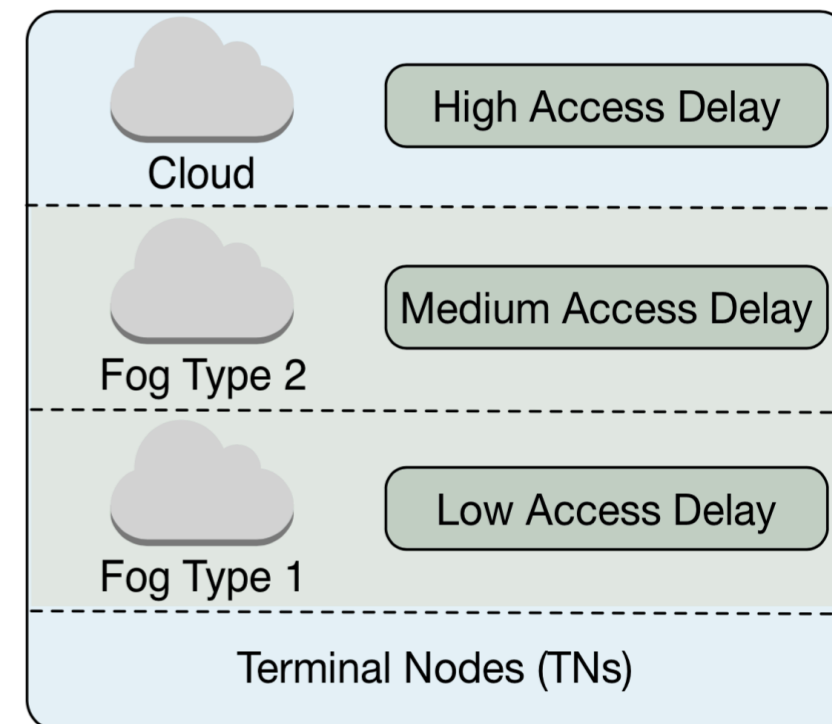
- **DDIO**, Dynamic Discovery of Internet Objects
- **DCDM**, Dynamic Configuration and Device Management
- **MPS-C**, Multi-Protocol Support: Communication Level
- **MPS-A**, Multi-Protocol Support: Application Level
- **Mob**, Mobility
- **CDA**, Context Discovery and Awareness
- **DA**, Data Analytics
- **SA**, Semantic Annotation
- **SP**, Security and Privacy
- **CCS**, Cloud Companion Support

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# Fundamental Survey of Fog Computing: Fundamental, Network Applications, and Research Challenges

- Three tiers: traditional fog network architecture
- Four tiers: for very low latency applications
- SDN-based: manage fog network resources



Architecture	Background	Focus/Contribution
Three-tier architecture [14], [43], [48], [54]	Basic architecture of fog computing.	To extend the computing and storage facilities towards network edge and to reduce burden on the cloud DCs.
Four-tier Combined Fog-Cloud (CFC) architecture [55]	Some service requests require very low end-to-end delay, however, current resource pool in the fog layer cannot support these requests, nevertheless, these requests do not necessarily to be executed in the Cloud.	<ul style="list-style-type: none"> <li>● The hierarchy of a layer is determined by capacity, vicinity, and reachability to EUs.</li> <li>● Two fog layers are suggested.</li> <li>● The fog second layer supports the service requests when there is not enough resource in fog first layer.</li> </ul>
SDN-based fog computing [94], [94], [97]	<ul style="list-style-type: none"> <li>● Separation of data and control plane.</li> <li>● Integrates controller functionality in edge-element, i.e., edge-switch.</li> <li>● Communicates with both fog and cloud management software.</li> </ul>	<ul style="list-style-type: none"> <li>● Improved controller-switch delay performance [94].</li> <li>● Effectively manages storage, computing, and networking resources of the edge-switch [94], [97].</li> <li>● Handles the Fog-related traffic with an aim to reduce latency and carbon footprint [96].</li> </ul>

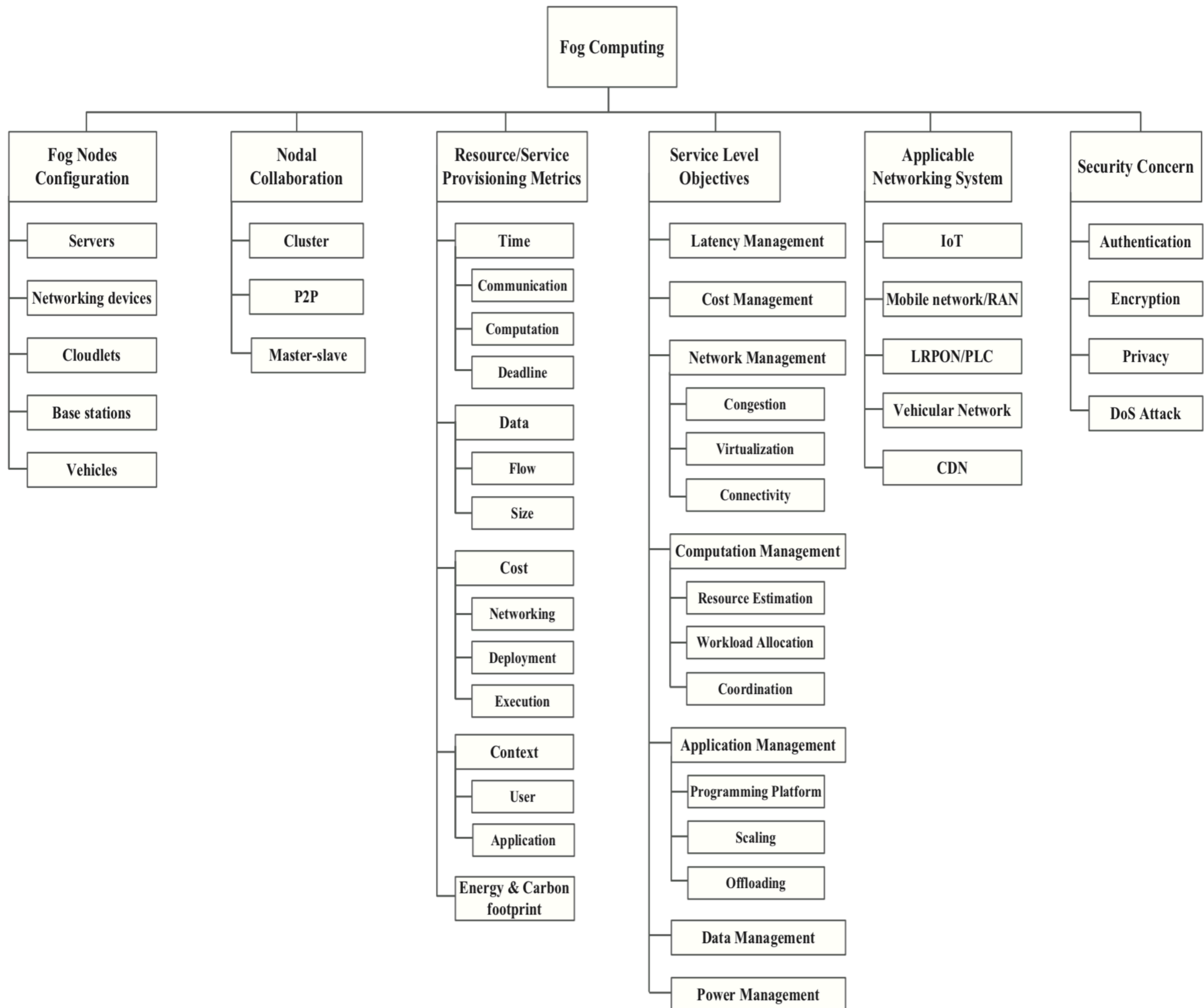
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# Fog Computing: A Taxonomy, Survey and Future Directions

- **Fog Nodes Configuration.** The computational nodes with heterogeneous architecture and configurations that are capable to provide infrastructure for Fog computing at the edge of the network.
- **Nodal Collaboration.** The techniques for managing nodal collaboration among different Fog nodes within the edge network.
- **Resource/Service Provisioning Metric.** The factors that contribute to provision resources and services efficiently under different constraints
- **Service Level Objectives.** The SLOs that have been attained by deploying Fog computing as an intermediate layer between Cloud datacenters and end devices/sensors
- **Applicable Network System.** The different networking systems where Fog computing has been introduced as extension of other computing paradigms
- **Security Concern.** The security issues that have been considered in Fog computing on different circumstances



Q&A

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