Seminarski rad
Sevisno-orijentisane arhitekture

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01

Šta je StarlingX?

- Open source projekat
- Software stack kreiran za IoT i Edge Computing
- Integriše već poznate open source komponente (CentOS, OvS-DPDK, Ceph, Kubernetes, OpenStack) sa svojim servisima
- Fokus na zahtevima IoT i Edge Computing-a

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Gde se koristi StarlingX?

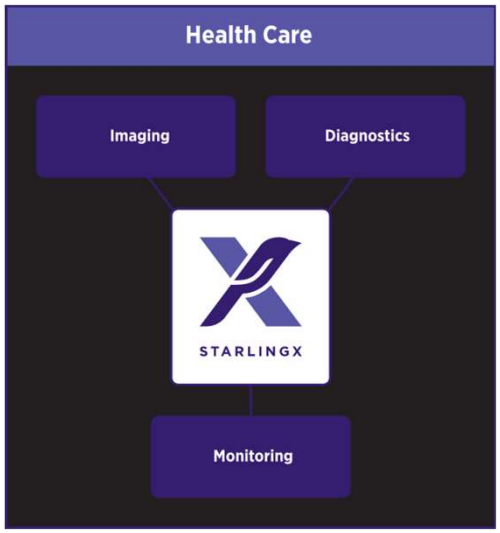
- Koristi se u najzahtevinijim industrijskim IoT sistemima, telekomunikacijama, streaming servisima...
- Namenjen za edge aplikacije koje zahtevaju jako nisko kašnjenje, veliku propusnost i bezbednost pri prenosu

Slučajevi korišćenja

Ultra Low-latency 5G and Industrial IoT (IIoT)

- Autonomous vehicles (drones, cars and trucks)
- Industrial automation (robotics and virtual Programmable Logic Controller - vPLC)
- Cloud/virtual Radio Access Network (cRAN/vRAN)
- Smart city/buildings (metering and monitoring)

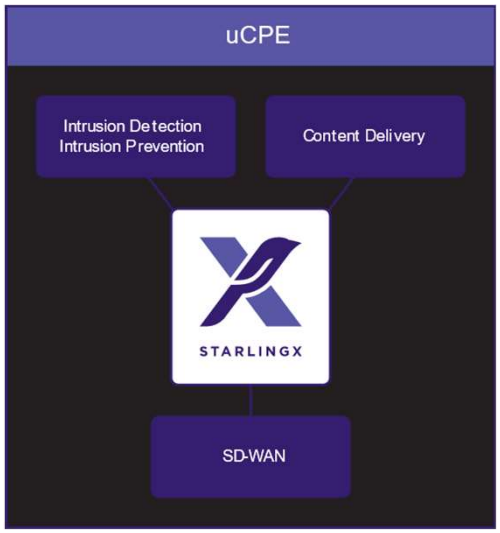
Slučajevi korišćenja



High Bandwidth, Large Volume Applications

- Mobile HD video
- Content delivery
- Healthcare (imaging and diagnostics)
- Caching and surveillance

Slučajevi korišćenja



Multi-access Edge Computing (MEC)

- Augmented and virtual reality (AR/VR)
- Enterprise focused small cell services for stadiums and high-density locations
- Unified Customer Premise Equipment (uCPE) applications
- Retail

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Koje su prednosti StarlingX-a?

- Open source projekat
- Fleksibilan za pokretanje u kontejnerima, virtuelnim mašinama, i/ili direktno na hardveru
- Optimizuje cloud servise za edge rešenja
- Pogodan za veliki opseg edge aplikacija

Karakteristike

Scalability

Reliability

Small Footprint

Ultra-low Latency

Edge Security

Lifecycle Management

Karakteristike

Scalability

- Deployable on one to thousands of distributed nodes allowing for a single system to be used from edge to core

Reliability

- Fault management, fast secure VM failover and live migration minimizes downtime

“Small Footprint”

- Providing a platform for edge and IoT use cases even for environments with tight resource constraints

Ultra-low latency

- Deterministic, tunable performance optimized for the use case

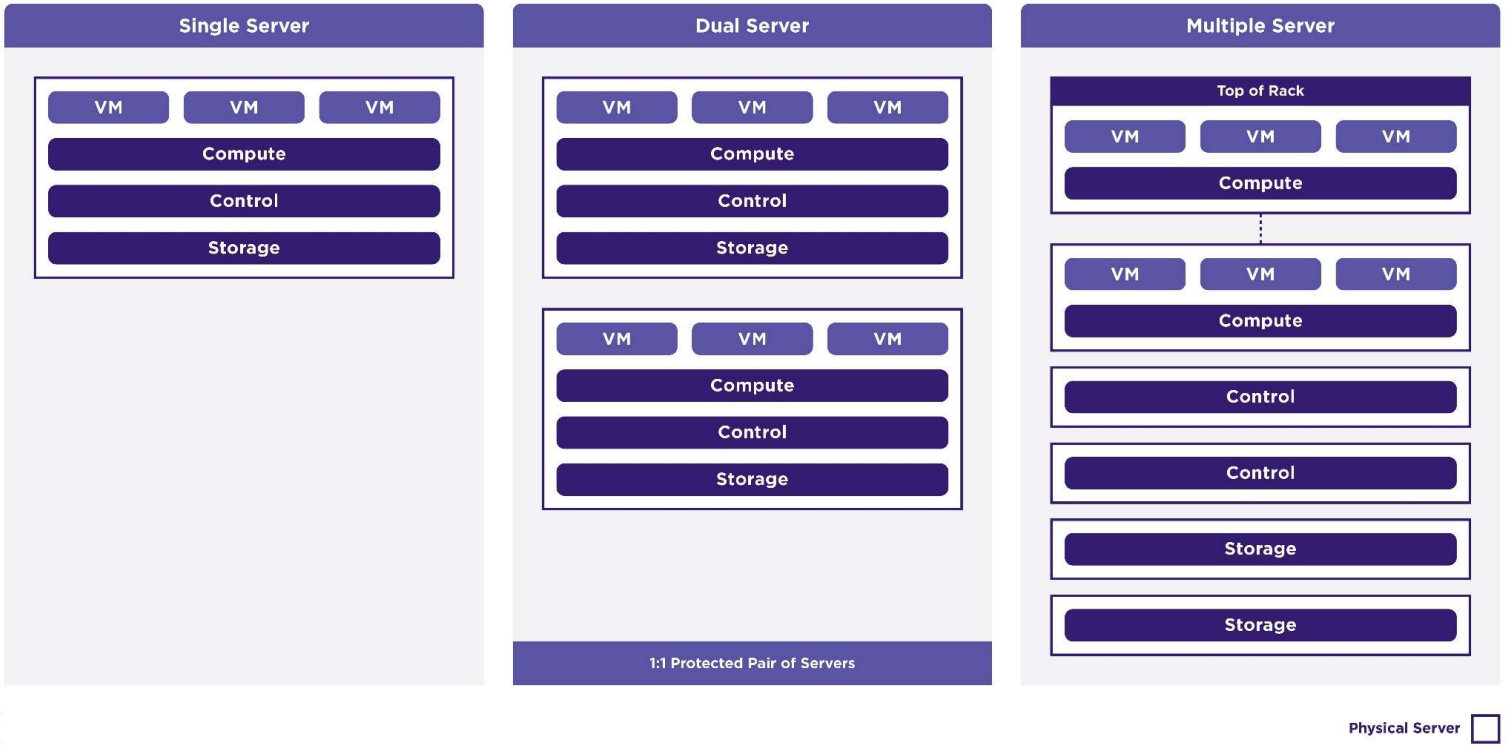
Edge Security

- Software security to avoid tampering at the edge, where physical security may be limited

Lifecycle managment

- Simplified deployment and operations with full system management through comprehensive orchestration suited for the edge

Scalability from small to large

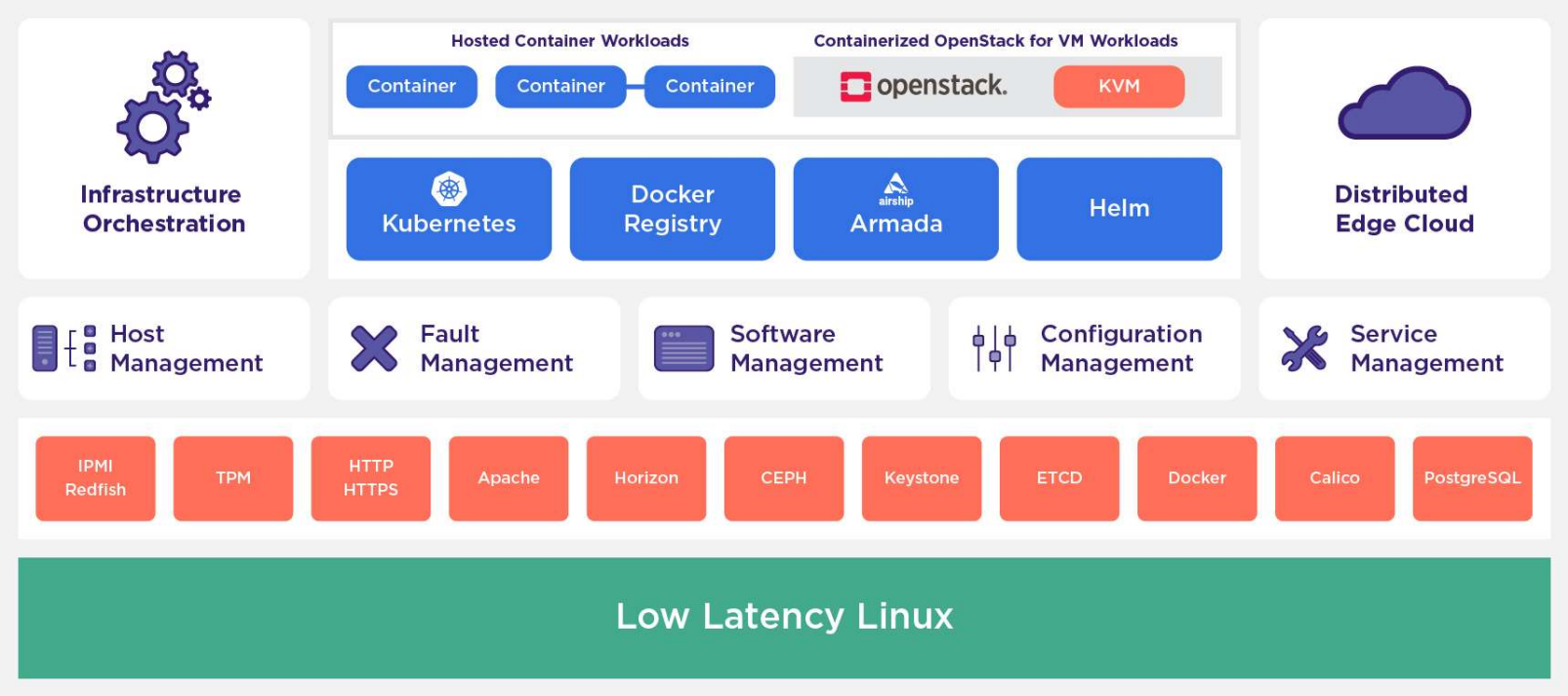


Single Server
Runs all functions

Dual Server
Redundant design

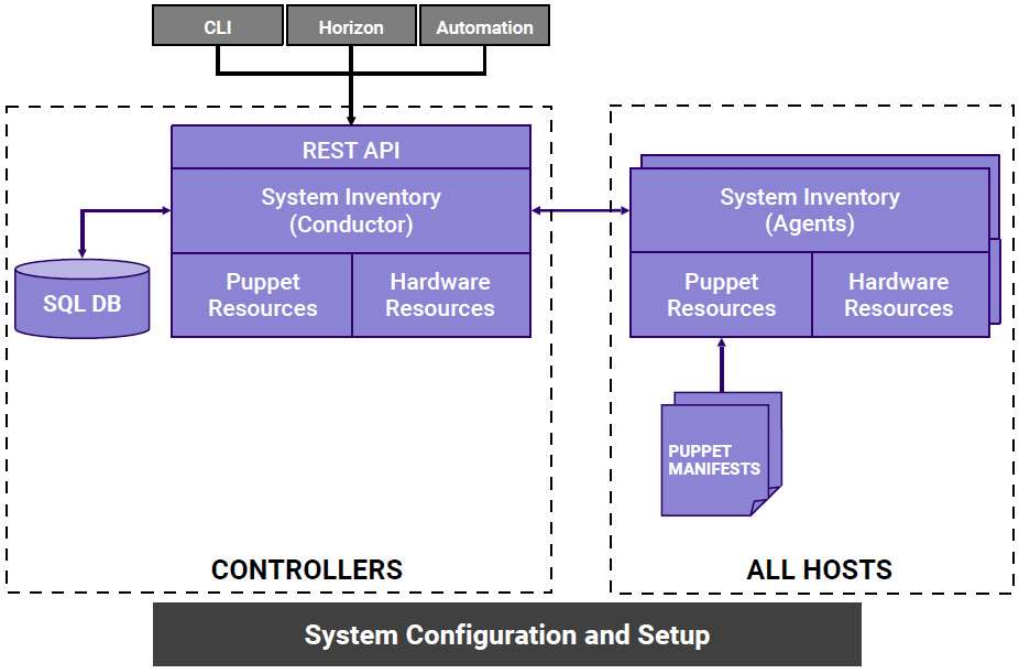
Multiple Server
Full resilient and geographically distributable

StarlingX Arhitektura



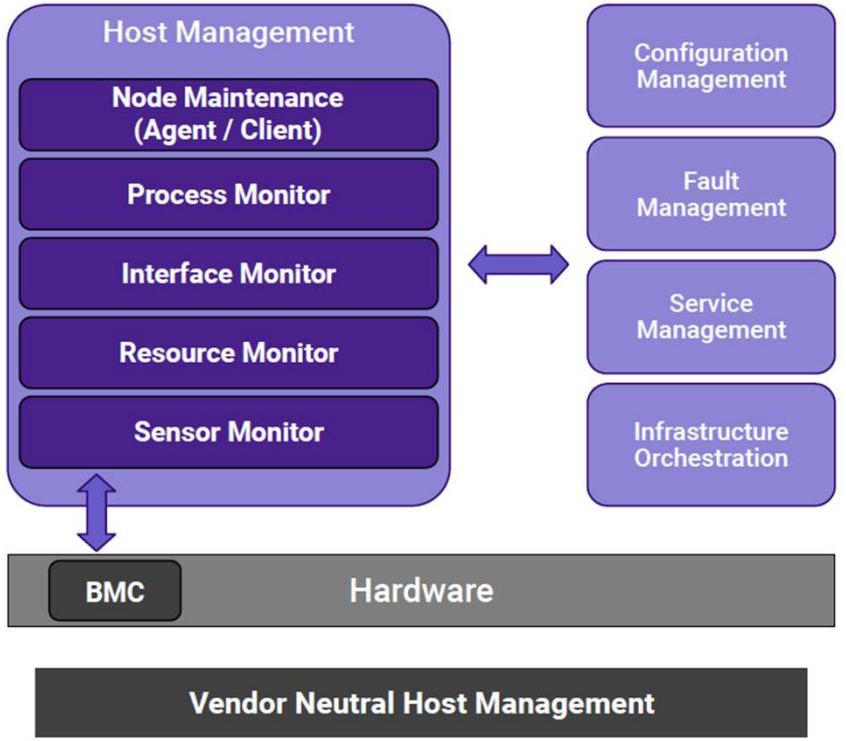
Configuration Management

- **Manages installation**
- Auto-discover new nodes
- Manage installation parameters (i.e. console, root disks)
- Bulk provisioning of nodes through XML file
- **Nodal Configuration**
- Node role, role profiles
- Core, memory (including huge page) assignments
- Network Interfaces and storage assignments
- **Inventory Discovery**
- CPU/cores, SMT, processors, memory, huge pages
- Storage, ports
- GPUs, storage, Crypto/compression H/W



Host Management

- **Full life-cycle management of the host**
- **Detects and automatically handles host failures and initiates recovery**
- **Monitoring and fault reporting for**
  - Cluster connectivity, critical process failures
  - Resource utilization thresholds, interface states
  - H/W fault / sensors, host watchdog
  - Activity progress reporting
- **Interfaces with board management (BMC)**
  - For out of band reset
  - Power-on/off
  - H/W sensor monitoring



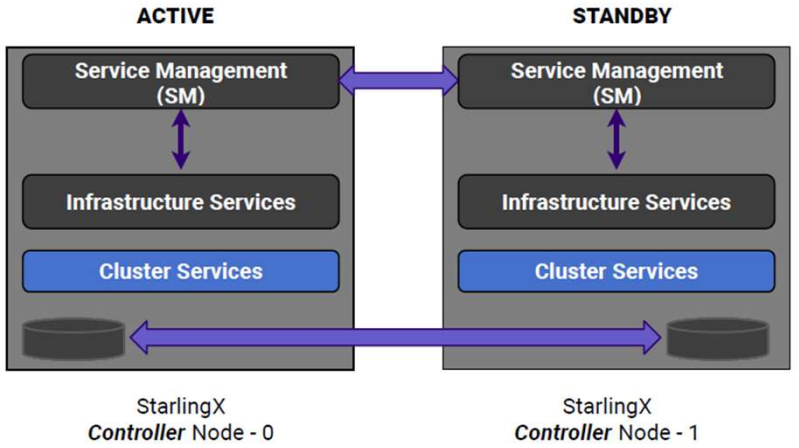
Service Management

- **High availability manager**
- Redundancy model can be N+M or N across multiple nodes
- Currently 1+1 HA Controller Cluster

- **Uses multiple messaging paths to avoid split-brain communication failures**
- Up to 3 independent communication paths
- LAG can also be configured for multi-link protection of each path
- Messages are authenticated using HMAC SHA-512 if configured / enabled on an interface-byinterface basis

- **Active or passive monitoring of services**

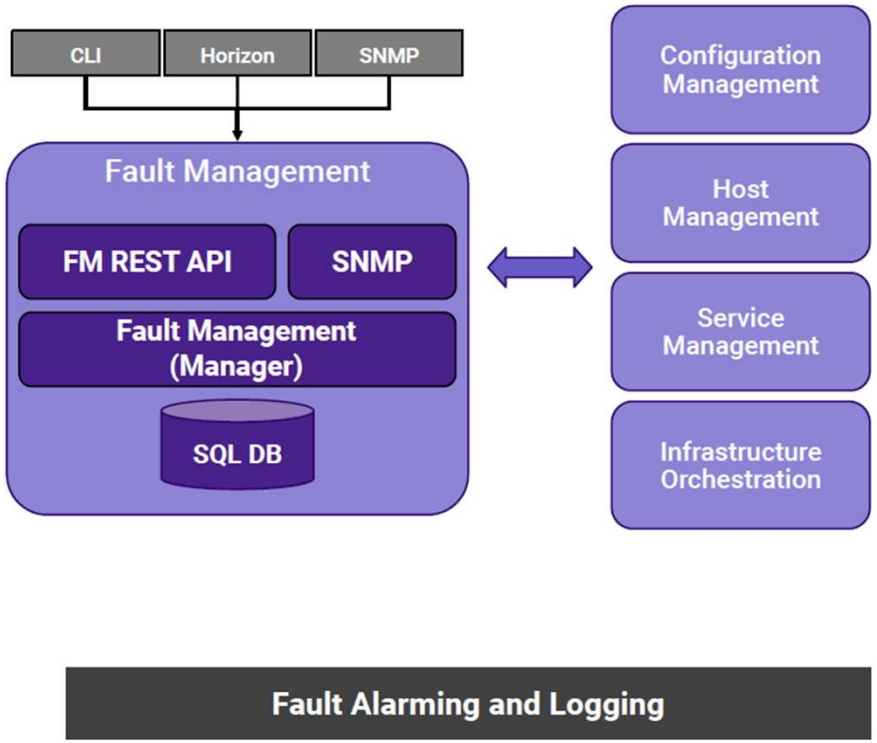
- **Allows for specifying the impact of a service failure**



High Availability for Critical Infrastructure

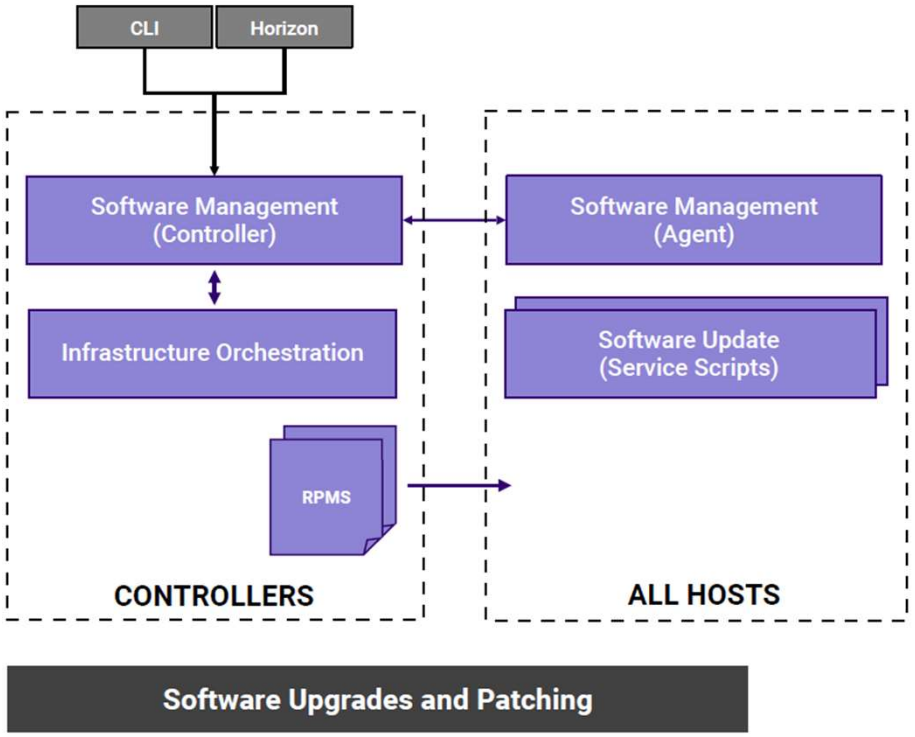
Fault Management

- **Framework for infrastructure services via API**
- Set, clear and query customer alarms
- Generate customer logs for significant events
- **Maintains an Active Alarm List**
- **Provides REST API to query alarms and events**
- **Support for alarm suppression**
- **Operator alarms**
- On platform nodes and resources
- On hosted virtual resources
- **Operator logs - Event List**
- Logging of set/clear of alarms
- Related to platform nodes and resources
- Related to hosted virtual resources



Software Management

- **Automated deploy of software updates for security and/or new functionality**
- **Integrated end-to-end rolling upgrade solution**
- Automated, low number of steps
- No additional hardware required for upgrade
- Rolling upgrade across nodes
- **In-service and reboot required patches supported**
- Reboot required for kernel replacement etc.
- VM live migration is used for patches that require reboot
- **Manages upgrades of all software**
- Host OS changes
- New / upgraded StarlingX service software
- New / upgraded OpenStack software



04

PTP – Precision Time Protocol

- Protokol za vremensku sinhronizaciju
- Omogućava tačnost ispod mikrosekunde
- IEEE 1588 (trenutno v2.1 – 2019)
- Originalna verzija nastala 2002. godine
- Master-slave arhitektura
- Koristi BMC algoritam (Best Master Clock)

> IEEE 1588 is designed to fill a niche not well served by either of the two dominant protocols, NTP and GPS. IEEE 1588 is designed for local systems requiring accuracies beyond those attainable using NTP. It is also designed for applications that cannot bear the cost of a GPS receiver at each node, or for which GPS signals are inaccessible.
>
> John Eidson

Razlika između i PTP i NTP (Network Time Protocol)

	PTP	NTP
Synchronization Accuracy	Millisecond accuracy	Sub-microseconds accuracy
Update Interval	Seconds	Minutes
Mode of Operation	Master pushes time to slaves	Clients pull time from server
Spatial Extent	LAN	LAN/WAN
Hardware Requirements	Hardware support required for higher accuracy, but not mandated	None, public NTP servers leverage hardware implementation
Error Source	Switches and port contention with data	Switches, port contention with data and OS stack delay

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Gde se koristi PTP?

- Koristi ga širok spektar sistema koji zahtevaju tačnost ispod mikrosekunde kao što su:
- sistemi za automatizaciju i vođenje
- sistemi za merenje i automatsko testiranje
- sistemi proizvodnje, prenosa i distribucije energije
- merenje udaljenosti, telemetrija i navigacija
- telekomunikacije

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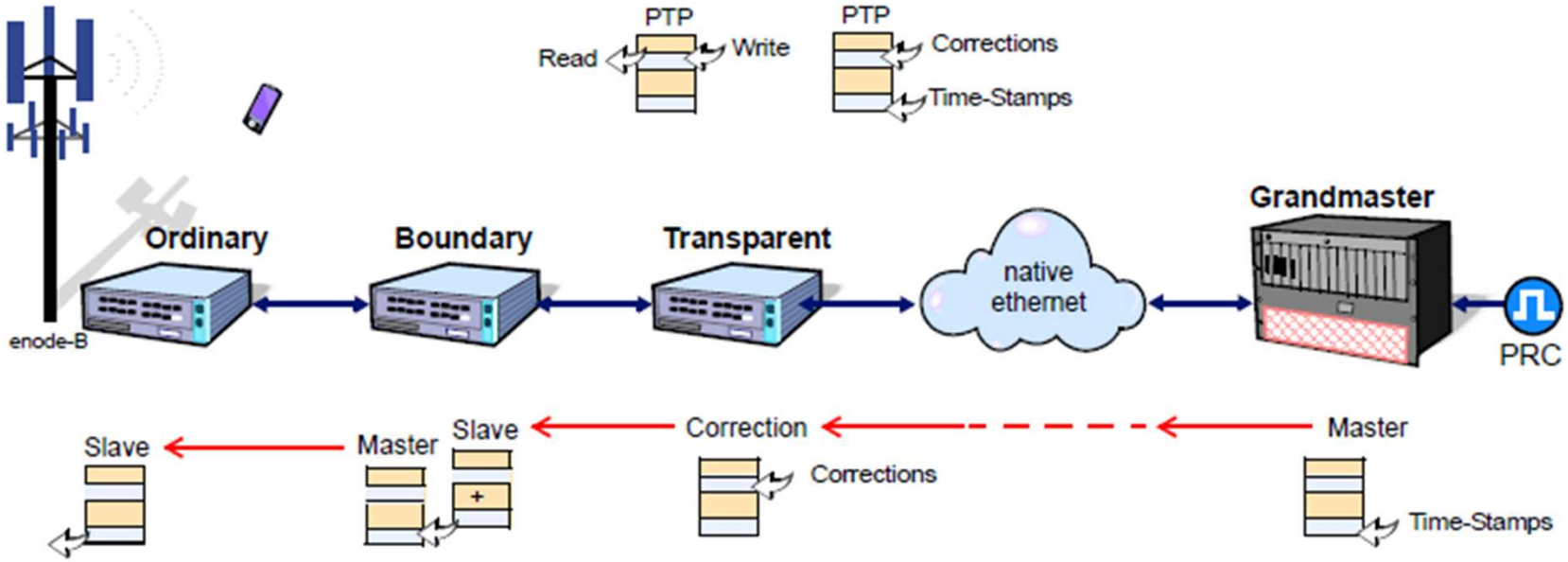
Gde će se koristiti PTP?

„Sistem distribucije vremena preko PTP protokola na teritoriji Republike Srbije je u fazi razvoja.“

Republika Srbija - Ministarstvo privrede
Direkcija za mere i dragocene metale

PTP



PTP was defined in the IEEE 1588 standard that describes a **master-slave** architecture for timing distribution across Ethernet / IP packet network. The standard offers some key advantages to manufacturers and operators that can deploy PTP compliant equipment and avoid the cost of TDM and potential jamming, operational and political issues that come with deploying GPS receivers at every base station.

PTP

Table 2

IEEE 1588v2 Device Description

Clock	Description	Operation
Ordinary	Single-port device that can be a master or slave clock	Read/Write time stamps
Grandmaster	Ordinary clock that manages the reference time	Write time stamps and responds time request from other clocks
Slave	Ordinary clock that keeps synchronized to the masters and provides synchronization to its clients	Write time stamps and responds time request from other clocks
Boundary	Multi-port device that can be a master or slave clock	Read/Write time stamps
Transparent (end-to-end)	Multi-port device that is not a master or slave clock but a bridge between both forwarding / correcting PTP messages	Write corrections
Transparent (peer-to-peer)	Multi-port device that is not a master or slave clock but a bridge between both forwarding / correcting Sync and Follow-up messages	Write corrections

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PTP implementacija u StarlingX-u

- Čvorovi raspoređeni u tri nivoa:
  - -Grandmaster Clock(s)
  - -Boundary Clocks
  - -Compute Hosts
- Koristi LinuxPTP implementaciju PTP protokola
- Konzistentna preciznost manja od mikrosekunde

Arhitektura u StarlingX-u

Grandmaster Clocks

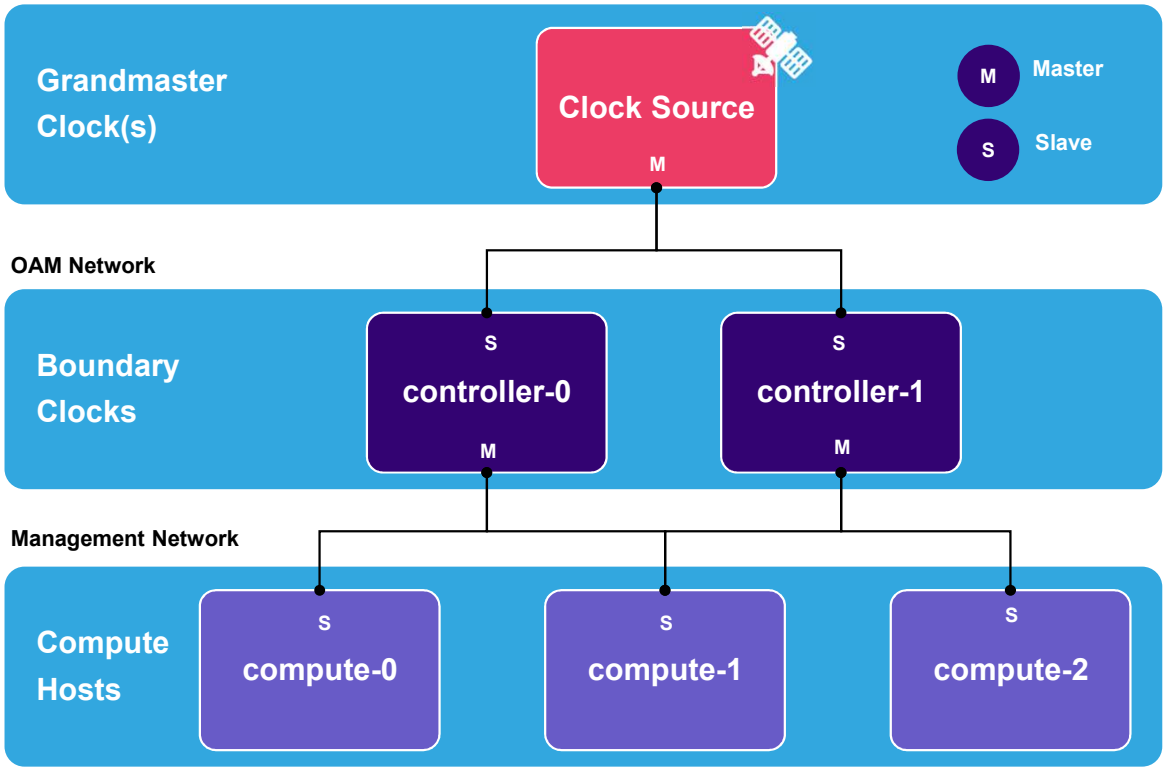
- Eksterni izvor vremena, najčešće baziran na GNSS/GPS

Boundary Clocks

- StarlingX Controller čvorovi
- Sinhronizuju svoj „clock„ sa Grandmaster-ovim preko „OAM Network“ nivoa
- Koriste se i kao izvor vremena za ostale čvorove
- Može da postane Grandmaster ako dođe do gubitka Grandmaster-a

Slave Clocks

- StarlingX Compute/Storage čvorovi
- Sinhronizuju svoj „clock“ sa StarlingX Controller čvorovima preko „Management Network“ nivoa



Konfiguracija u StarlingX CLI-u

system ptp-modify --enabled=<true/false> --mode=<hardware/software> --transport=<l2/udp> --mechanism=<e2e/p2p>

- Uključivanje/isključivanje PTP-a i konfigurisanje njegovih parametara
- --enabled; uključi ili isključi PTP
- --mode; odabir moda
- --transport; odabir transportnog protokola (Layer 2/User Datagram Protocol)
- --mechanism: odabir delay mehanizma

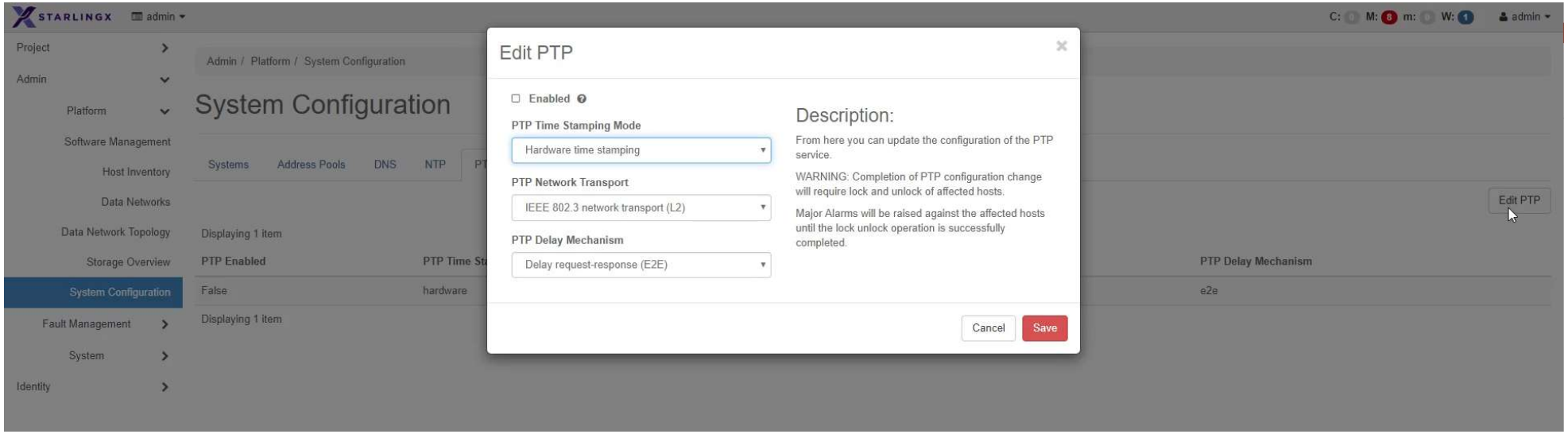
StarlingX Configuration Manager distribuira izabranu konfiguraciju kroz čvorove

system ptp-show

- Komanda za prikaz trenutne konfiguracije

```
+--------------+--------------------------------------+
| Property     | Value                                |
+--------------+--------------------------------------+
| uuid         | c004fbee-c0e3-4b7f-a7f7-11e1ff85b7a1 |
| enabled      | True                                 |
| mode         | hardware                             |
| transport    | l2                                   |
| mechanism    | e2e                                  |
| isystem_uuid | ab7e1c1c-ef20-4df0-84fa-376580dce689 |
| created_at   | 2019-04-10T15:58:42.627974+00:00     |
| updated_at   | None                                 |
+--------------+--------------------------------------+
```

Konfiguracija u StarlingX GUI-u (Horizon)



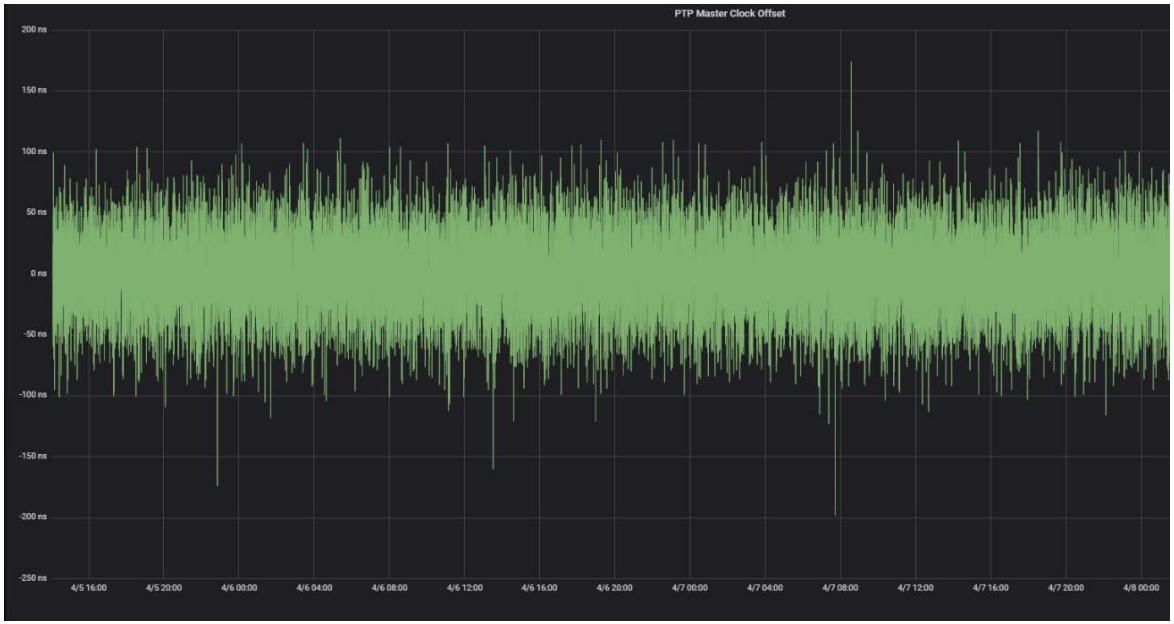
PTP Monitoring and Alarming

PTP Accuracy Monitoring

- StarlingX konstantno prati offset između Master i Slave clock-a i čuva tu informaciju zbog praćenja rezultata i otkrivanja greške

PTP Status Alarming

- StarlingX šalje alarm ako dođe do neprihvatljivog offset-a između Master i Slave clock-a (>1ms)
- NICs (Network Interface Controllers) koji ne podržavaju hardware mod PTP se takođe prijavljuju



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StarlingX PTP Demo

Open Infrastructure Summit
Denver, Colorado
April 29 – May 1, 2019

StarlingX PTP Demo

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Literatura

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