Building Network Management Systems
Your Course

- Unit 1 - Principles to Network Management
- Unit 2 - Internet Network Management (SNMP)
- Unit 3 - Telecommunication Management (OSI/TMN)
- Unit 4 - Web Based Enterprise Management (DMTF)
- Unit 5 - Knowledge driven Management technology
Definitions

“Network management refers to the activities, methods, procedures, and tools that pertain to the operation, administration, maintenance, and provisioning of networked systems” Clemm

A Network Management system is a software system that implements and supports Network Management

› Craft Terminals
› Element Managers
› Network Management Systems
Management of the “Networked System” or the “Communication Network”

Management of the Communication Network

Management of the Networked System
CHALLENGES
Challenge: Heterogeneity

› Network Types
  › GSM
  › UMTS
  › LTE
  › 5G

› Network Element Types
  › Macro, Micro, Pico, Femto
  › Cell Overlays

› Devices

› Services
Challenge: Scale

- Increases in the number of network elements
  - In mobile networks, capacity per cell is limited
  - Increasing capacity means increasing the number of cells
  - Hundreds of thousands

- Increases in the numbers complexity of terminals
  - Tens of millions

- Increase in Data Traffic
  - Tens of millions of sessions active
  - Approach 1TB/s data volumes

Building Network Management Systems
Challenge: Virtualization

- Networks
  - SDN
- Nodes
  - NFV
Challenge: Service Management

User → Network Operator → Service Provider → Equipment Vendor

- User
- Network Operator
- Service Provider
- Equipment Vendor

KPI → KQI → Events → Aggregated Events → Aggregated Traffic Flow Data → Traffic Session Data → UE Customer Experience Monitoring → User Complaints → CDRs

- Service Aspects
- Service Aspects
- Service Aspects

Service Knowledge

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Other Challenges

› Customer Management
  – Interfaces to CRM and Billing systems
  – Churn identification
  – Identification of valuable customers
  – Grouping and categorization of customers and services

› “Traditional” FCAPS
  – All must work with Heterogeneity, at Scale, Virtually, and with Services and Customers
APPROACHES
Distributed Management Platform

- Management platforms provide general purpose management functionality
- They provide common functionality for managing any network such as Fault Management and Performance Management
- They are highly adaptable and can be customised to manage any network
- They are multi-technology and multi-vendor systems
Distributed management Platform
System Support and Common Components

› System support in management platforms delivers quality attributes to the platform that are transparent to the applications
  – The ability to run component instances on any available machine
  – Distributed persistence, distributed transaction support, addressing transparency

› Common components are components that many applications may wish to use
  – Model and Meta modelling handling and support
  – Event processing or data mining support
  – Common topology handling
  – Support for intra and inter application communication such as message passing systems and application servers
  – Support for scheduling jobs and batch processing
Distributed Management Platform
Common and Custom Applications

› Common applications are provided that cover management functionality that is required for all networks
  – Applications Fault management, Performance management, Inventory Management and software management
  – Common applications can usually be extended and adapted to handle specific requirements of service providers

› Custom Applications may be developed on management platforms
  – A development environment or development kit is provided
  – Custom applications use the same APIs as common applications
  – A service provider may require a custom application for a feature that is used over networks provided by different vendors
  – The management platform vendor may provide custom applications as a service
Distributed Management Platform
User Interface and UI Abstraction

› Many types of user interface may be supported such as web clients for status updates or thick Java clients for planning tools

› The User Interface layer
  – Renders the view of the user interface
  – Allows the user to change screens using docking, to change themes and skins

› The User Interface Abstraction Layer
  – Holds the model and controls the views of active clients
  – Maps the network models in common applications and common components into UI models
  – Handles mapping and location
  – Is customisable for different client types and customers
Distributing Management

- Management systems always work towards network elements that are distributed.

- A distributed architecture for a management system can:
  - Spread the management workload.
  - Reduce management traffic load by processing information locally.
  - Increase system reliability by removing single points of failure.
  - Improve the scalability of the management system.

- Distributed approaches:
  - Have higher costs because extra equipment deployed in networks.
  - Can make the management architecture more complex.
  - Can themselves be complex to manage, for example coordinated software upgrade is required.
Distributing Management: SON [3]

› Distributed SON (D-SON) (Favoured by Ericsson)
  – Functions distributed among the network elements at the edge of the network
  – Real Time
  – Normally supplied by network equipment vendor

› Centralized SON (C-SON)
  – Functions concentrated closer to higher-order network nodes or Management System
  – Allows a broader overview of more edge elements and coordination of e.g. load across a wide geographic area.
  – Often supplied by 3rd parties

› Hybrid SON
  – A mix of centralized and distributed SON, combining elements of each in a hybrid solution
  – Systems evolving towards hybrid SON now
Distributing Management: SON Use Cases [3]

- **Planning**
  - NodeB Location
  - NodeB HW Configuration
  - NodeB Radio Parameter
  - Network Integration
  - NodeB Transport Parameter
  - aGW / OMC Parameter

- **Deployment**
  - HW Installation
  - Network Authentication
  - Software Installation
  - Transport Parameter Setup
  - Radio Parameter Setup
  - Testing

- **Optimization**
  - Radio Parameter Optimisation
  - Transport Parameter Optimisation

- **Maintenance**
  - Hardware Extension /Replacement
  - Software Upgrade
  - Network Monitoring
  - Failure Recovery

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Distributing Management: ANR[4]

- Neighbour relation table (NRT) for each cell.
  - Cell 1 has a complete knowledge
  - Cell 2 knows Cell 1, not Cell 3
  - Cell 3 knows Cell 1, not Cell 2
  - Cell 4 is newly installed, has no knowledge

- ANR function allows base stations to find each other’s cells and build relations automatically
Virtualizing Mobile Networks: ETSI NFV [5]

- Replace bespoke dedicated proprietary nodes, with Virtual Network Functions (VNF)
- Network Function Virtualization for mobile telecommunications networks
  - eNBs: base stations
  - Core Nodes: MMEs, SGWs, PGWs, HSSs
- VNFs can be deployed, redeployed and undeployed much faster than physical nodes
- Nodes connected over standard connections
- Networks are heterogeneous
  - Radio Technologies: 2G, WCDMA, LTE, Wireless LAN
  - Macro, Micro, Pico, and Femto cells, Operation Support Systems
Virtualization of Mobile Networks: Factors

› Management Systems must continue network Operation and Management (OAM) tasks as before

› Manage Virtualization seamlessly
  – Manage the VNFs themselves
  – Manage the cloud infrastructure
  – Maintain network deployment consistency in virtual environments and between virtual and physical environments.

› Larger scale, Dynamic, and Agile Networks
  – Virtual nodes may have lower performance characteristics
  – Many small virtual nodes with single functions
  – Multi-function large nodes may disappear

› NFV will drive large-scale, dynamic and agile networks
The Challenge: Morph Mobile Networks to NFV

It works great on PowerPoint
And Manage Lots of Them!

Telecommunication Management

Unvirtualised Network

Unvirtualised Network

NFV Cluster

NFV Cluster

Control

Traffic

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Current Management Systems Assume

› Functions are on nodes physically connected into the network
› Nodes are discovered or they are informed of a node’s existence
› Configuration parameters are read, deduced, or fetched from a pre-planned configuration to bring its network functions into service
› The fundamental operation of the node and its connections will remain stable and change rarely.
› Management is over an NBI with adaptation to hide the idiosyncrasies of its syntax and semantics
But Now . . .

› Network functions can exist in and across virtualized and physical infrastructure
› Network functions can now appear, change characteristics, and disappear in an ad-hoc manner
› Internal connections and Interconnections between VNFs are over SDN can change at any time.
› NFV architecture provides Vi-Ma and Os-Ma interfaces for VNFs dynamicity
› The management interfaces to functions that are candidates to be NFVs are not “Virtualization Aware”
Trivial Example: Introduction of a VNF

1: Management system monitors Real and Virtual Network a..d using NBI, Vi-Ma and Os-Ma

2: Load increases: Management System spins up VNFe using Vi-Ma and Os-Ma

3: Management System uses NBI to redistribute load across VNFd and VNFe

4: Management System uses NBI to set up new connection between NFa and VNFe, possibly load balancing towards VNFd

5: Management System uses NBI to set up new connection between NFc and VNFe, possibly load balancing towards VNFd

6: Management System uses NBI to set up new connection between NFb and VNFe, possibly load balancing towards VNFd
Technologies in Product

- Linux (RHEL) on Real Blades or Virtual Machines
- OpenStack virtual deployment on clouds
- Most development in Java, some c++ for high performance applications
- JEE/JBoss used for application transparency
- Column store RDBMS systems used for persistence
- JMS used for messaging
- Apache Hadoop used for large scale storage
- “Big Data” analytics using Apache Storm and Map/Reduce techniques
Emerging Technologies: Stream Analytics

Event Loader α
- Event Parser (Type A Files)
- Event Parser (Stream B)
- Event Parser (File Type Y)
- Event Parser (Stream Z)

Event Loader β
- Event Parsers

Event Loader ω
- Event Parsers

Distributed Event Bus

Event Correlator a
- Subscriber
- Publisher
- Correlator

Event Correlator z
- Subscriber
- Publisher
- Correlator

Event Persister I
- Subscriber
- Database/File Mediator

Event Persister J
- Subscriber
- Database/File Mediator

External System R
- Forwarder
- Subscriber

External System S
- Forwarder
- Subscriber
Emerging Technologies: Adaptive Policy Based Management

- Adaptive Policies
  - Policies can be changed in real time
  - Policies can adapt to their environment

- Uses Ontologies for Context
  - Captures relationships in policy environment
  - Policy Conflict identification and mitigation
Other “Hot” Topics

› Autonomic Management
  – Closely related to SON
  – Closely related to Analytics and Policy Based management

› IoT Management
  – Highly distributed
  – Very high scale but low volumes

› C-RAN
  – Virtualization of the Radio Access Network
  – Only the Radio subsystem is “real”
SUMMARY
Summary

› A Management System is a software system for managing networks
› Major Challenges are Heterogeneity, Scale, Virtualization, and Service Management
› A Distributed Management Platform, Feature Distribution, and Virtualization can help meet those challenges
› Modern Management Systems use the most advanced software technology
References

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Ericsson NM Lab Job

Research Engineer/Applied Researcher- Analytics and Machine Learning
› Successful candidates will carry out cutting-edge research, design innovative solutions for network management problems by applying advanced analytics and machine learning techniques to develop proof-of-concepts.

Global Graduate Program - Software Developer
› Software development roles in requirement analysis, design, integration, verification, and configuration management.
This is ericsson athlone

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Diversity
49 Nationalities

Felllities
€10M Renew
€5-8M Test Sites

Global R&D Responsibility

Local R&D Suppliers

R&D

Outsourced Operations
India

Innovation

C1150 People (from 850 in '13)
320 Hires since ‘13
~200 Grads

87 Patents Last 5 yrs

< 30
Age
%
Our customers