Overlay Networks

Computer network which is built on the top of another network.

Popular Overlay Networks:
1. NAPSTER, YOUTUBE,....
2. MUMBAI DABBAWALLAHS

Diversity, QoE, Personalization,

Network over Railways, Roadways
IEEE P1903 (NGSON)  
Next Generation Service Overlay Networks  

Niranth - P1903 WG  
Huawei R&D India - Bangalore  

(31 Jul-2013/IEEE/Workshop)  
Bangalore, India
Agenda

- P1903 Project Status
- NGSON Story
  - Challenges & Opportunities
  - Use Cases & Requirements
  - The Functional Architecture
  - The Protocol Specifications
IEEE P1903 (NGSON)

- An IEEE sponsored effort to standardize a framework of IP-based service overlay networks
- A set of context-aware, dynamically adaptive, and self-organizing networking capabilities, including advanced routing and forwarding schemes
Position of NGSON Standards

- Applications
  - Transport Layer
  - Service Layer
  - App Support Layer
- NGSON
  - Service Related
  - Transport Related
- Network Services
  - OSE (ITU-T)
  - NGN (ITU-T, ETSI)
  - SDP
  - IMS (3GPP)
  - P2P, Web, Cloud
  - EPC (LTE) (3GPP)
  - SDF (TMF)
- Business Layer
- IP

[Diagram showing the position of NGSON Standards within different layers of the communication network.]
Key Milestones

Feb-2007, Idea published to IEEE

May-2008, WG 1st meeting

Sep-2007, NGSON SG 1st meeting

NGSON (IEEE P1903) standardization

1Q 2009, WG completes the White Paper on NGSON

Oct 2011, NGSON AD becomes an IEEE Standard

Oct 2011, IEEE ComSoc approves 3 new PARs

2Q 2009, WG completes the NGSON Requirements Document

October 2011, IEEE ComSoc approves 3 new PARs

Jan 2011, WG Completes the NGSON Functional Architecture Document

Jan 2013 Participation changed from Entity based to Individual based

Sponsored by IEEE ComSoc and CaG
## Documents Status

<table>
<thead>
<tr>
<th>Document Type</th>
<th>Status</th>
<th>Quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Paper</td>
<td>Released</td>
<td>1Q09</td>
</tr>
<tr>
<td>Requirements</td>
<td>Frozen</td>
<td>2Q09</td>
</tr>
<tr>
<td>Architecture</td>
<td>Standardized</td>
<td>3Q11</td>
</tr>
<tr>
<td>Technical Specs</td>
<td>Started</td>
<td>3Q11</td>
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</table>
New PARs Approved by IEEE

- Content Delivery (P1903.1)
  - Technical Standard for Content Delivery Protocols of NGSON

- Service Composition (P1903.2)
  - Technical Standard for Service Composition Protocols of NGSON

- Self-Organizing Management (P1903.3)
  - Technical Standard for Self-Organizing Management Protocols of NGSON
NGSON Pointers

- **Website:**
  - http://grouper.ieee.org/groups/ngson/index.html

- **Contacts:**
  - Mehmet Ulema: mehmet.ulema@manhattan.edu
  - Niranth: namogh@huawei.com
  - Lisa Perry: L.Perry@ieee.org
NGSON Story

- Challenges & Opportunities
- Use Cases & Requirements
- The Functional Architecture
- The Protocol Specifications
## Current Challenges

<table>
<thead>
<tr>
<th>Network Operators</th>
<th>Service &amp; Content providers</th>
<th>Vertical Industries &amp; Companies</th>
<th>End Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth requirement exploding</td>
<td>Major income from advertisement</td>
<td>Internet portal becomes necessity</td>
<td>I love Internet !!!</td>
</tr>
<tr>
<td>Internet services – good QoE</td>
<td>Internet services are popular</td>
<td></td>
<td>Services and Advertisements are everywhere</td>
</tr>
<tr>
<td>Voice is still major income source</td>
<td></td>
<td>Internet portal becomes necessity</td>
<td>Telecom services are stable</td>
</tr>
<tr>
<td>Data services increasing dramatically</td>
<td></td>
<td></td>
<td>Limited services, not attractive at all</td>
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<td></td>
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<td></td>
<td>Too stiff, not adaptive</td>
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<td>Becoming spam, but still hard to find out critical services in time</td>
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<tr>
<td></td>
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<td></td>
<td>Limited services, not attractive at all</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Too stiff, not adaptive</td>
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<td>It’s dangerous if you are exposed</td>
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<td>Sometimes QoS is a problem</td>
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<td>ARPU decreased, revenue eroded</td>
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<td></td>
<td></td>
<td>Minor income with heavy burden</td>
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<td></td>
<td>Challenged by VoIP with zero price</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Price competition will come soon</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>No such thing called ARPU</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>User activities are anonymous, hard to locate target customers proactively</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>How about mission critical business?</td>
</tr>
</tbody>
</table>
Opportunities

Mobile Internet is challenging operators profitability and they need to think about transforming their networks and business model in the next 3 years (Developing country operators need to take important decision by Q3 2014. Business cannot be sustained by simply increasing the capacity or “dumb pipes”) – TellLabs Study
NGSON enables Service Ecosystem

NGSON based Service Layer Infrastructure

- Intenet Web
- Email
- Weather
- Social
- Hotel
- Air ticket
- NGSON based Service Layer Infrastructure
- Telco Service APP
- Presence
- CALL
- Customer Care
- Location
- SMS

Government

- Education
- Environment
- Development and Reform
- meteorological
- Land &Plan
- Social
- Smart Metering
- dispatch automation
- Smart Grid
- Grid Management
- Vouching
- Smart Metering
- Other Industry (M2M)

- Other N/Ws
  - P2P
  - Web

- IMS
  - SR <-> CSCF
  - IDM <-> GUP
  - SPD <-> PDF
  - CD <-> MRF
  - Enhancing IMS Service Interactions

- EPC (LTE)
  - SPD <-> PCRF
  - CD <-> P-GW
  - Construct the MBB App Layer for 3GPP EPC

- SDP
  - Media <-> CD
  - Orchestration-SC, SR, SDN
  - Scaling SDP. Orchestration of value chain in multiple provider env.

- Cloud and SDN
  - NGSON uses Cloud and SDN
  - Providing PaaS layer, building the SaaS, using IaaS. Flexibility to Apps.

Telecommunications

- mHealth
- eHospital
- Medical Record
- Health Care information
- Remote monitor
- e Health

Other Industry (M2M)

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E2E Use Case for NGSON

- **Step 1:** NGSON makes all the Services and APIs available from various networks of a Service Provider and the Partners.
- **Step 2:** Compose a Service Chain (eg. Video content service) by Orchestrating the services, service functions and network functions using NGSON.
- **Step 3:** Deploy the Service Chain. NGSON understands the service chaining specification and initializes the related NGSON functions.
- **Step 4:** Service is provisioned to the End User for a certain instance type (Usually a factor of cost). NGSON prepares to execute the Service Chain for the particular instance type by issuing commands to functions of NGSON like:
  - **Service Discovery:** To discover the destination services appropriate for the Service Chain for the instance type.
  - **Service Routing:** To setup the routes of the Service Requests to appropriate destinations and support Self Organization in terms of Self-Optimization, Route re-configuration and Fault Recovery.
  - **Content Delivery:** To setup efficient content delivery for the service with the help of Context Information and Service Policy Decision functions of underlying networks like P2P, Cloud, CDN, SDN, etc.
  - **Operation and Management:** To automatically self-organize the NGSON Physical systems to realize the Service Chain. (Manage the OPEX)
- **Step 5:** NGSON provides high QoE Service Delivery considering the dynamic situations of the User, Network, Service and Device. Also providing flexible charging options.

Examples for NGSON Service are:
- **Bandwidth Service** (User selected services + Charging Plans)
- **Mashup Service** (Internet Content + Telco Service)
Open APIs

Applications and Services

NGSON

Underlying Networks (Transport & Access)

SERVICE DELIVERY CHAIN

Multi-Industry Services

Customers
Service Abstraction

Chain Services (Abstract)

Instantiate over different services & networks (SDN, etc) with Differentiated Experience and Cost
Dynamic Service Composition & Adaptation
Service Delivery Orchestration

- User Presence: Presence information of the user including the current channel being watched by the user.
- Address Book: Know your friends
- Advertisements: Provides users advertisements of preference
- IPTV MASH UP
- Value Added Services: Communication Services for connecting communities.
- Location: Location information provides location of friends.

User can create mash up of preferred advertisements.
Self Organization

Topology-1

SReg FE, SDN FE, SR FE
NODE 1

SP FE, SC FE, SPD FE, CD FE, SR FE
NODE 2

IDM FE, CIM FE, OM FE, SR FE
NODE 3

FEs on NODE 1 are re-allocated to NODE 2 due to the failure of NODE 1

Topology-2

SP FE, SC FE, SPD FE, CD FE, SR FE, SReg FE, SDN FE
NODE 2

IDM FE, CIM FE, OM FE, SR FE
NODE 3

Topology-3

SReg FE, SDN FE, SP FE, SC FE, SR FE
NODE 4

SPD FE, CD FE, SR FE
NODE 2

IDM FE, CIM FE, OM FE, SR FE
NODE 3

NODE 4 is added and SReg, SDN, SP and SC FEs are re-allocated from NODE 2 to NODE 4

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NGSON Requirements

Common
- Addressing
- Interaction
- Interworking
- Cross-layer
- ID Management
- QoS
- Security
- Service framework to 3rd party providers
- Infrastructure virtualization
- Global ID

Service
- Service routing
- Service registration
- Service Discovery and Publication
- Negotiation
- Service Composition
- Charging
- Seamless Mobility
- Context Awareness
- Service related Self Organization
- Brokering
- Service Co-ordination
- Service Collaboration
- Virtualization
- Messaging for O&M through Service Routing
- Service related P2P Overlay
- Service replication
- Community based services

Delivery
- Network Routing
- Transport Related Functions
- Self Organization Adaption
- Identity
- Resource Virtualization
- Network Composition
- Resource Scheduling
- Network Traffic Optimization
- Transport related P2P Overlay

O&M
- Manageability
- FCAPS
- Lifecycle management
- Service arrangements and provisioning between providers
IEEE NGSON Architecture

**Features**

- **Self Organization**
- **Context Awareness**
- **Dynamic Adaptation**
- **Service QoS**

10 Functional Entities
20 Reference Points

Legend

- Entity standardized by NGSON
- Entity standardized out of NGSON
- Reference Point standardized by NGSON
- Potential reference point FFS
- Logical Reference point for composite service

R1, R2, R3, R4 are external reference points
R1 - R10 are internal reference points

Supporting Composition & Discovery & Negotiation
Service interaction and Service forwarding techniques
Allows user access to NGSON services
User and Service level Authentication & Authorization

Static & Dynamic Service Chaining and Instantiation
Maintenance of Service Dynamic Information
Self Organization of NGSON structure and functions.
Service, Network, Device, User contexts mgmt.
QoS Negotiation and Assurance

Content adaptation, cache and forward techniques

Underlying Networks
NGSON Key Features

- Context Awareness
- Dynamic Adaptation
- Self Organization
- Service Routing
- Service Discovery and Negotiation
- Service Composition
- Content Delivery
- Service Mobility
- Security
- Service QoS
- Charging Events

These key features are realized through interactions between the various NGSON FEs as described in NGSON Architecture.
Examples of Key Features (1/5)

- **Service Substitution in Service Composition**

1. Service request
2. Route to composite service
3. Service execution, invoke service
4. Invoke base service
5. Invoke base service failure
6. Route failure information
7. Service execution, substitute service
8. Service discovery and negotiation request
9. Return selected service
10. Service execution, invoke service
11. Invoke base service
12. Route to base service
13. Service response
14. Route response to SC FE
15. Service execution, reply response
16. Service response
17. Route response
### Service QoS Life cycle

<table>
<thead>
<tr>
<th>Any- FE</th>
<th>SDN FE</th>
<th>CIM FE</th>
<th>SPD FE</th>
<th>QoS Decision Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Publish request of QoS setup/update</td>
<td></td>
<td></td>
<td></td>
<td>QoS configuration</td>
</tr>
<tr>
<td>2. Store/update QoS information</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3. Publish response</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Discover request with QoS Criteria</td>
<td></td>
<td></td>
<td></td>
<td>QoS Discovery</td>
</tr>
<tr>
<td>If Context criteria is used,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Get QoS related Context</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Context response</td>
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</tr>
<tr>
<td>4. Discover a service satisfying QoS criteria</td>
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</tr>
<tr>
<td>5. Discover response</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Perform Service QoS requirement</td>
<td></td>
<td></td>
<td></td>
<td>QoS Enforcement</td>
</tr>
<tr>
<td>2. Split the service QoS into service related QoS and transport related QoS</td>
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<tr>
<td>3. Enforce the service related QoS</td>
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<tr>
<td>4. Send the transport related QoS to the transport</td>
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<tr>
<td>5. Authorize the resources and control the QoS enforcement</td>
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<tr>
<td>6. Service QoS requirement response</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Monitor request of QoS</td>
<td></td>
<td></td>
<td></td>
<td>QoS Assurance</td>
</tr>
<tr>
<td>4. Monitor response</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Monitoring QoS</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>3. QoS Analysis and Enforcement</td>
<td></td>
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</tr>
</tbody>
</table>

IEEE
Examples of Key Features (3/5)

- Service Mobility (Roaming)
Examples of Key Features (4/5)

- Dynamic Adaptation

<table>
<thead>
<tr>
<th>Adaptation category</th>
<th>Adaptation examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service level</td>
<td>Service substitution (e.g., the use of another service component), service negotiation, dynamic service routing, and dynamic SC, dynamic selection and composition/decomposition of services, dynamic invocation of an appropriate service at runtime, dynamic QoS and media flow delivery based on context.</td>
</tr>
<tr>
<td>User level</td>
<td>Multiple user interfaces for a service based on user’s situation</td>
</tr>
<tr>
<td>Network level</td>
<td>Dynamically connects to an optimal network</td>
</tr>
</tbody>
</table>

Service Requester

1. Service request
2. Service execution & obtain service & decide SLA for the composite service
3. Monitor request (service QoS)
4. Monitor request (service/device/network context)
5. Invoke base service (route to base service)
6. Service response
7. Service response
8. Service is provided during a period (e.g., media services)
9. Monitor Notify (failure to requested QoS)
10. Analysis status & select alternative composite service with new (or same) SLA
11. Monitor request (service QoS)
12. Invoke base service (route to new base service)
13. Service response
14. Service is provided during a period (e.g., media services)
15. Monitor notify (changes of service/device/network context)
16. Analysis status & select alternative composite service with new (or same) SLA
17. Monitor request (service/device/network context)
18. Invoke base service (route to new base service)
19. Service response
20. Service is provided during a period (e.g., media services)
Examples of Key Features (5/5)

- Self Organization
  - Self Configuration
  - Self Optimization
  - Self Recovery

<table>
<thead>
<tr>
<th>Self-organization category</th>
<th>Self-organization examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Node level</td>
<td>Self-recovery, self-optimization and self-configuration</td>
</tr>
<tr>
<td>Function entity level</td>
<td>Self-recovery, self-optimization and self-configuration</td>
</tr>
<tr>
<td>Service level</td>
<td>Dynamic negotiation, composition and substitution</td>
</tr>
<tr>
<td>Transport level</td>
<td>Network parameters tuning and transport-related substitution</td>
</tr>
</tbody>
</table>

OM FE Involved Self Organization

OM FE Non-Involved Self Organization
X-Aware Service Ecosystem

AS, Apps, ...
CPE, Mobile Handset, ...
IM, LBS, Social N/Ws, ...

Software Defined Network (SDN)
Telecom N/Ws (NGN, IMS, EPC)
Other N/Ws (Web, P2P, IT)

Device Awareness
Network Awareness
Application/Service Awareness
User Awareness
Current P1903 Standard Specifications

- Focus on Standardization based on Key Features.
- Approach for Careful consideration and Fast Deployment.
- P1903.1
  - Content Delivery Protocols of NGSON
- P1903.2
  - Service Composition Protocols of NGSON
- P1903.3
  - Self-Organizing Management Protocols of NGSON
P1903.1 – Content Delivery

- **Purpose of P1903.1**
  - for network operators, service/content providers, and end users
  - to provide and consume content services based on advanced content delivery capability of NGSON
    - with context-aware and dynamically adaptive features.
  - to provide interoperability of content services between network operators and content providers.
NGSON Content Delivery Operations

- Content Delivery Request Operation
- Content Discovery Operation
- Content Location Update Operation
- Content Storage & Cache Operation
- Content Delivery Channel Setup Operation
- Transport QoS dispatch Operation
- Transport QoS enforcement Operation
- Context Information Request Operation
- Content Delivery Service Operation

Cloud
SDN
Context Aware
This standard specifies protocols among Service Composition (SC) Functional Entity (FE), Service Discovery and Negotiation (SDN) FE, Context Information Management (CIM) FE, Service Routing (SR) FE and Service Policy Decision (SPD) FE to support service composition capabilities in next generation service overlay network. The capabilities of service composition aim to support service chaining and instantiation, specification interpretation, service brokering and execution, and context-aware and dynamically adaptive service composition.
NGSON Service Composition Operations

1. Create Abstract Service

2. Instantiate Abstract Service

3. Deliver the Composite Service
NGSON network operators to reduce OPEX of NGSON networks based on self-organizing management capabilities of NGSON including self-configuration, self-recovery and self-optimization of NGSON nodes and functional entities.
NGSON Self Organization Operations

Self Configuration

ADD NGSON FUNCTION ENTITY
DELETE NGSON FUNCTION ENTITY
MOVE NGSON FUNCTION ENTRY
COPY NGSON FUNCTION ENTITY
ACTIVATE NGSON NODE
DEACTIVATE NGSON NODE

Large Scale Deployment (Cloud)
Automated Management
Virtualized NGSON Functions
Decoupling Hardware and Software

NODE Level
FUNCTION Level
SERVICE Level
TRANSPORT Level

If Controlled by Overlay Management

- Define Operations for Self-Organization
- Define Triggers for Self-Organization

If Not Controlled by Overlay Management

- P2P Self-Organizing Management
NGSON Impact on Monetization Trend

Application Needs are Orchestrated across various service and network abstractions in a cost effective way.

SDN (Open Flow) & NfV allows to create a more powerful application strategy based on NGSON for the service provider.
Thank you!

Contact: namogh@huawei.com
BACKUP SLIDES

More Details on NGSON Architecture
1. Service Composition

- **Service Brokering**
  - Static and Dynamic Service Chaining and Instantiation
  - Abstraction of Services for re-composability
  - Control the composition
- **Specification Interpretation**
- **Adaptation**
  - Re-composition
  - Optimization for best performance
  - Context Awareness
- **Charging**
2. Service Discovery and Negotiation

- **Discovery**
  - Service matching based on service criteria and context
  - Service selection
  - Service Recommendation (list of similar services) based on Service Identity

- **Negotiation**
  - User profile based and Response based.
  - Subscription and Notification
  - Content Location Discovery
3. Service Routing

- Service Routing
  - Forwarding based on service address, class, etc.
  - Context Aware Forwarding to single or multiple destinations (Intelligent)
  - Support the Service Composition adaptation
  - Interaction with other NGSON FEs

- Support Self Organization
  - Dynamic Adaptation of Overlay Network for context changes

- Service QoS Dispatch
  - Interfacing with SPD FE

- Charging Event Support
4. Service Register

- Retrieval and Update
  - Real time Service Registration
  - Manage dynamic information of the Service
- Service Address Mapping
  - Service Address Resolution to IP
5. Identity Management

- **Authentication and Authorization**
  - User and Service Level Identity Control and Mgmt.
  - Manage Identities based on Groups and Communities
  - Global ID – Support Single Sign On

- **ID Mapping**
  - Interoperability between Global (NGSON), Local (Service Provider specific) and Temporary (Anonymous) IDs

- **User Profile Mgmt**
  - User Data Models
6. Context Information Mgmt

- **Context Aggregation**
  - Context Collection from different sources
  - Context change Monitoring

- **Context Processing**
  - Transformation and Filtering of Context Data and modeling different contexts.

- **Provide high level contexts through interpretation**
- **Reasoning of context information**

- **Context Dispatch**
  - Provide context for NGSON operations and applications.

---

<table>
<thead>
<tr>
<th>Context class</th>
<th>Examples of context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service context</td>
<td>Service-related information such as service QoS, service performance, service availability, service roaming state, service triggers (such as policies, user feedback, and location), content, service category, service fees, service provider, and location where the service is available.</td>
</tr>
<tr>
<td>User context</td>
<td>User-related information such as location, environment constraint, terminal equipment used, preference, presence.</td>
</tr>
<tr>
<td>Network context</td>
<td>Network-related information such as network conditions (e.g., bandwidth, traffic topology) and performance.</td>
</tr>
<tr>
<td>Device context</td>
<td>Device-related information such as hardware configuration of device (e.g., device model, display, input/output modality), software configuration of device (e.g., operating system, mobile platform), and status of device (e.g., received signal strength (RSS), battery power, memory consumption).</td>
</tr>
</tbody>
</table>
7. Content Delivery

- **Receive**
  - Storage selection (Cache vs. Permanent)
  - Location update with SDN FE
  - Distribution Policy Control for different storages and contents (stream vs. files)

- **Aggregation**
  - Storage (Cache, Cloud, CDN, etc)
  - Merging and Synchronization

- **Send**
  - Best Delivery
  - Unicast vs. Multicast

Enables support for protocols like HTTP, FTP, P2P, RTSP, etc.
8. Service Policy Decision

- **Service QoS Requirement Dispatch**
  - Analyze & Derive the service QoS requirement from request.

- **QoS Negotiation**
  - Determine the best service provider based on resource state.
  - QoS admission control

- **Resource State Monitoring**
  - Query underlying networks
  - Monitoring

- **QoS Enforcement**
  - QoS reservation in the underlying network.
  - Allocate acceptable QoS based on the actual network condition.
9. Service Portal

- **Portal**
  - Subscribe to NGSON Services in Real time
  - Registration of Global ID
  - Forms the Service and content requests
  - NGSON Services Information rendering to the user.

- **Log-on**
  - Interface for Login.
  - Login session handling
  - Support authentication for service requests.
10. Operation and Management

- Overlay Management
  - Manages the Node and Functions information (Topology)
  - Capability negotiation with Physical systems

- Node Monitoring
  - Manages dynamic information of NGSON Nodes (resource)

- FE Instance Monitoring
  - Dynamic information of FE Instances (Status and Performance)

- Role Assignment and Modification
  - Reconfiguration for nodes and functions in NGSON.
NGSON over Underlay Networks (1/3)

NGSON over IMS

Service Composition of IMS and non-IMS Services

NGSON Node

NGSON Functional Entity over IMS

IMS

NGSON Functional Entity

Underlying Network
NGSON over Underlay Networks (2/3)

- NGSON over P2P

NGSON integration with P2P Service

1. JOIN the P2P network
2. FETCH content X
3. Analyse content request
4. FETCH content X
5. RECEIVE content X (P2P Way)
6. Cache Content (Optional)
7. DELIVER content X

P2P Node
NGSON FEs
P2P Links
P2P Node
NGSON FEs
P2P Links
P2P Links
NGSON FEs
P2P Node

P2P Services

NGSON

IEEE
NGSON over Underlay Networks (3/3)

- NGSON with Web
  - Interaction (Security, Diversity, Sessions, Context Awareness & Adaptation) of Web Resources and NGSON Services.
  - Service Delivery – App Stores, Web Desktops, etc.
  - Service Composition - Mashups